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GLASS MAKING IN SOUTHERN CALIFORNIA

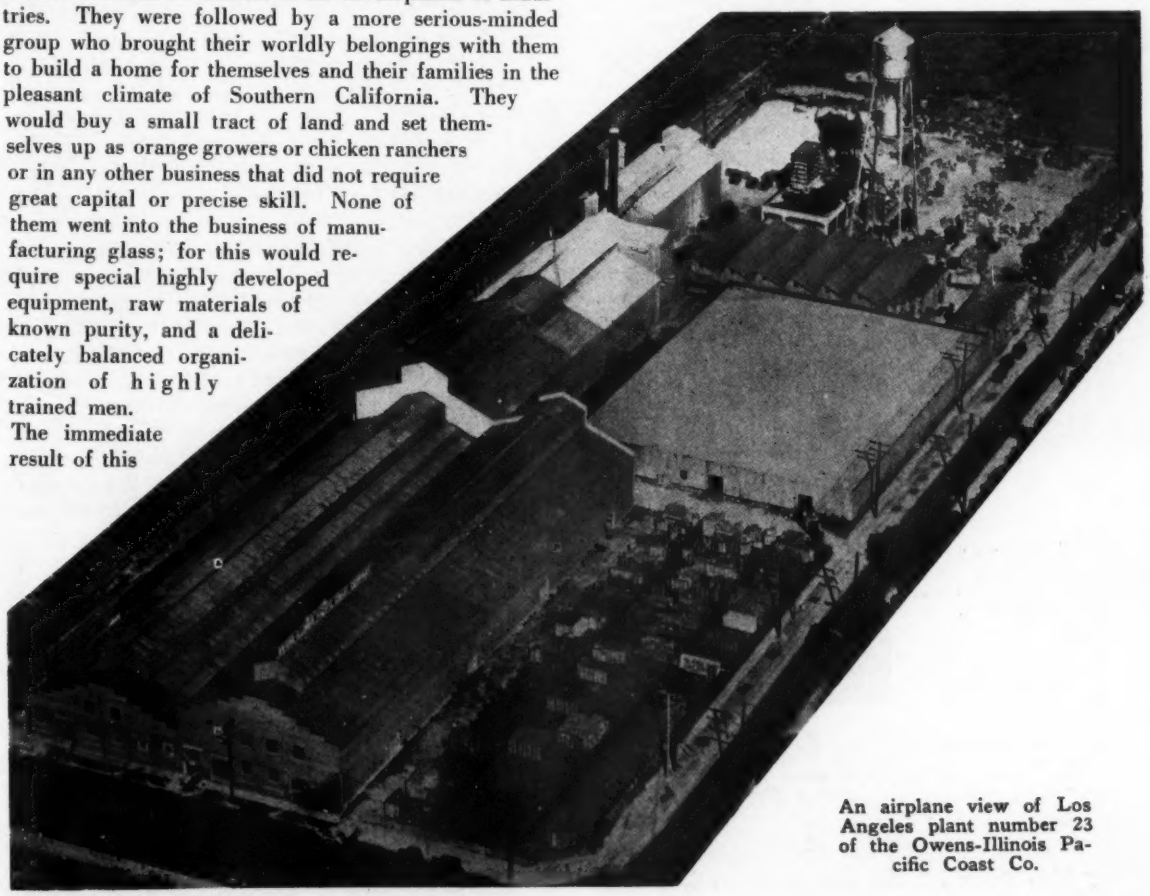
By ROY E. SWAIN

THE story of glass manufacturing in Southern California is one that is closely linked with the amazing mushroom-like growth and development of this fertile section of the United States.

Fifty years ago, Los Angeles was a town with barely 10,000 inhabitants surrounded by a number of ranchos whose boundaries are still in existence. In the past 50 years, figures for each succeeding census, with the exception of World War years, have more than doubled those of the previous census. Two thirds of the present population came to California after the World War and there are now more than 3,000,000 people living within a radius of 150 miles of Los Angeles. The completion of the Colorado River project will offer opportunities to twice as many more people.

The earliest settlers were adventurers and pleasure seekers who had no interest in the development of industries. They were followed by a more serious-minded group who brought their worldly belongings with them to build a home for themselves and their families in the pleasant climate of Southern California. They would buy a small tract of land and set themselves up as orange growers or chicken ranchers or in any other business that did not require great capital or precise skill. None of them went into the business of manufacturing glass; for this would require special highly developed equipment, raw materials of known purity, and a delicately balanced organization of highly trained men. The immediate result of this influx of people from all over the United States was a tremendous building boom in the vicinity of Los Angeles, shortly after the World War. In 1923, the city of Los Angeles alone issued building permits totaling over $200,000,000, and in that and the four years following more than a billion dollars worth of construction was done in Southern California. Building regulations required a high percentage of window area based on the floor space and architects, there being no heating problem, not only used windows for lighting and ventilating but for decorative purposes as well. To furnish all of these new buildings required lighting glassware and table glassware, not to mention all of the containers and glass specialties that are a part of modern living.

Hundreds of miles of broad highways were being built and these were bordered with the latest lighting units



An airplane view of Los Angeles plant number 23 of the Owens-Illinois Pacific Coast Co.

mounted on concrete or metal standards. Along these highways sprang up thousands of service stations, some of them with as many as 24 of the visible type glass pumps displaying in their glass cylinders the various colored gasolines developed to distinguish the different brands.

Concurrently, the fruit and vegetable canning industry of Los Angeles, which has been turning out a product valued at more than $5,000,000 yearly, is utilizing glass more and more for its containers. Pickles, jams, nut meats, peanut butter and salad dressings, not to mention chicken, ravioli, tamales and pickled pigs feet, are being packed in glass in the Los Angeles district. Large quantities of fruit juices and syrups demand bottles to take them to market. And the recent comeback of the California wine industry with its promise of still further development offers a rich opportunity to enterprising bottle manufacturers.

Here was certainly a need for glass for housing, tableware, transportation and containers. And California, being a long way from most other glass-making centers, it seemer profitable to make glass there rather than ship it by railroad. But at any rate, here was the demand.

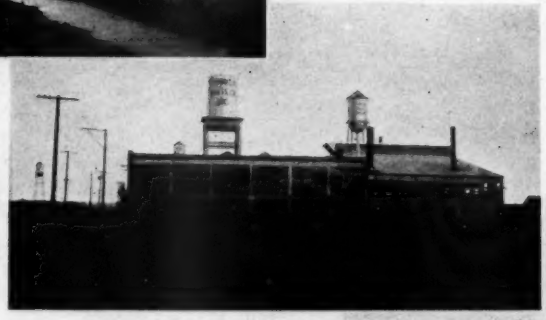
Raw Materials. Southern California has abundant raw materials for the manufacture of glass. Glass being about 70 per cent silica and California being three parts sand, there is plenty of sand of which all types of bottle glasses and colored glass for other purposes may be made. For very high grade flint and crystal, either Illinois or Pennsylvania sands are used. Sand from Belgium is also used, being imported to this country as ballast. The chemical analyses and screen tests shown in the adjoining column are typical of three sands which are widely used in Southern California.

Chemical Analyses	*Spartan (Nev. Pac. Mineral Co.)*	*Corona*	*Belgian*
SiO_2	99.10	92.95	99.46
Al_2O_3	.69	3.37	.304
Fe_2O_3	.047	.075	.043
CaO	Trace		
Screen Test			
+20	0.0	0.1	0.1
+30	2.0		
+40	13.0	53.1	11.0
+60	40.3	27.2	31.9
+80	15.1	17.8	50.9
+100	14.8	.9	2.6
—100	14.5	.9	2.6

Fuel. Almost as important as the raw materials themselves in such an industry as glass-making are abundant facilities for cheap fuel. Southern California has a plentiful supply of natural gas with a rating of 1100 to 1125 b. t. u. per cu. ft. This gas, at the time of writing, is available for industrial purposes at 15 cents per thousand cubic feet and can be had at 12 cents per thousand when subject to certain emergency regulations. Its price is controlled to some extent by the price of fuel oil which has sold for a number of years at 65 cents per barrel of 42 gallons.

Here were raw materials and fuel and a climate that provided ideal working conditions. Freezing weather* was unknown and on the hotest summer day there is always a cooling breeze off the ocean. Here seemed to be the opportunity of a lifetime. Glass factories sprang up on all sides. They ranged from small daytanks in back yards to well-financed and well-planned factories. At one time there were 35 in the Los Angeles district and

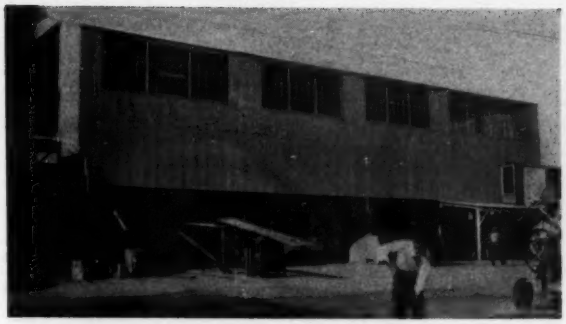
*You can't keep the weather out of any discussion of California.—Ed.



A trio of Southern Californian glass plants, Brock, Technical and A. H. Forgar companies.

Other raw materials may also be found in Southern California. Limestone of exceptional quality is found in ten of the southern counties, and a number of these deposits are suitable for glass. Inyo county offers a deposit of dolomite. There are also deposits of quartz of very high grade but the expense of crushing and screening has made its use for glass prohibitive. The discovery of borax did much to make Death Valley famous, but more accessible deposits have been found in Searles Lake, Owens Lake, San Bernardino and Inyo counties. This borax is refined by the American Potash & Chemical Co., Pacific Alkali Co. and the Pacific Coast Borax Co. Dense soad ash is prepared by the Pacific Alkali Co. and the Natural Soda Products Co. from deposits in Inyo county and San Diego.

The glass and pottery trades find an ample supply of feldspar in San Diego and Inyo counties. Deposits of potash, barium, fluorspar and lepidolite are being worked in Southern California, and these materials will no doubt be available to the glass manufacturer.



(Left) End of blowing room, Latchford Glass Co. (Right) The Maywood Glass Co., founded in 1929.

failures were so common that investors were warned to beware of glass factory promoters. These plants, however, did serve to train men and to make extremely vivid the requirements for manufacturing glass.

One of the primary difficulties during this pioneering period was the labor situation. There were simply no highly trained glass technicians and workmen available. As a matter of fact, the labor situation in Southern California, even today, is unique. There is a great deal of cheap foreign labor available but it is confined chiefly to the many large-scale agricultural projects, whereas the majority of the industrial plants are comparatively small and employ a very high percentage of native white labor. The school census of Huntington Park, one of the residential sections of the industrial district (see map), shows that 97 per cent of the school children are of American born white parents. This ratio does not vary greatly as in the other industrial sections of Southern California. The fact that this skilled labor is paid according to the national wage scale, when combined with low living expenses, makes for a very happy labor situation. However, the low foreign labor costs concern only a few situations where unskilled labor is usable.

As a matter of fact, one of the chief causes of the early failures of glass companies in Southern California was this lack of skilled workmen. Dr. R. D. Tiffany, when appointed to straighten out the finances of a small flint glass factory located in Newport Beach, immediately sent East for skilled workmen and his call was answered by Wm. A. Anderson, Fred Glassen and Gus Conradsen.

They found that their predecessors were attempting to produce good glass in a poorly constructed melting unit made of inferior materials. They abandoned this site and organized the West Coast Glass Co., nearer the market, to manufacture a general line of pressed and blown glass. However, the demand for milk bottles was so great that the entire plant was soon devoted to them.

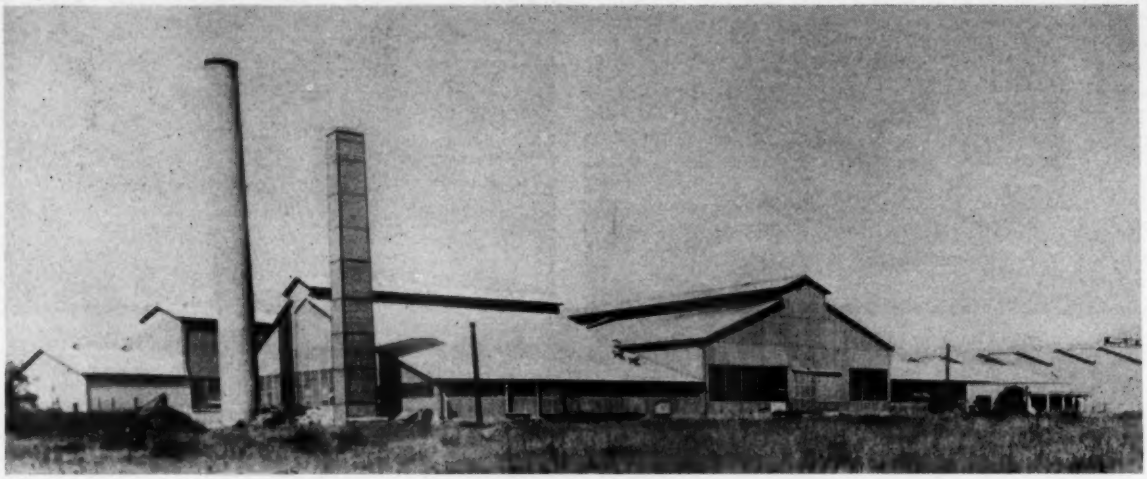
Glass Containers. The entire history of glass-making in Southern California appears to be based on the enterprise of a few men with their changing affiliations and the organization of new manufacturing units. Thus, Wm. A. Anderson and his associates, shortly after organizing the West Coast Glass Co., formed the Technical Glass Co., and securing a small building, started making glassware of all types. This was in 1919. Then came the great Los Angeles building boom which demanded tremendous quantities of glass for builders' hardware and the company was forced to move into larger quarters. Today, they make an extensive line of flint glass as well. Besides considerable private mold work, they manufacture a number of staple lines such as bird baths and seed cups, glassware for fountain dispensers and vending machines, ashtrays and novelties. They have also recently added more than 100 new drinking glasses to their line. Their melting equipment consists of two continuous tanks and four day tanks in which opal, black, crystal and a large variety of transparent colors may be melted.

Equally enterprising was William McLaughlin who started a bottle factory in his backyard with the assistance of a small tank and two helpers. He was, however, able to convince William J. Latchford that bottle-making had commercial possibilities and the Southern Glass Co. was organized with a group of highly trained engineers and salesmen to produce bottles and containers. In 1920, two years after starting the Southern Glass Co., McLaughlin withdrew and started the McLaughlin Glass Co. for making hand-made water bottles. A line of gallon, half gallon, beer and liquor bottles are made in flint, amber, light and dark green. There are three 15 ton and two smaller continuous tanks as well as a small day tank in this plant.

The McLaughlin Co. was also building up the production of flint glass for which there was a large local demand. Two insulator presses, six side lever presses, a press and blow machine and specially built machines made up their equipment for this. The blow furnace and swing hole are used by a pair of well-known window glass workers, Gaston and Franz Cornell, in the making of large cylinders, fish globes, garden furniture and moving picture properties.

While McLaughlin was developing his own business, Mr. Latchford concentrated his efforts on the Southern Glass Co. until 1925 when he resigned to start the Latchford Glass Co. with his stepson, Baird Marble. They located on one of the main trucking routes to the harbor, having selected enough land to enable him to more than double his plant and production facilities as the bottle business in the West grows. In the main plant, there are today three continuous machine tanks of 45, 35 and 20 ton daily capacity. The hand tank has a daily capacity of 15 tons. The forming equipment consists of five Hartford-Empire feeders and five Lynch R machines for the production of liquor, beer, vinegar and bleach bottles as well as jars for jams and pickles. The hand plant makes five-gallon water bottles. Testing laboratory, three large warehouses, all-steel factory buildings—all sprang from a small tank in Wm. McLaughlin's backyard.

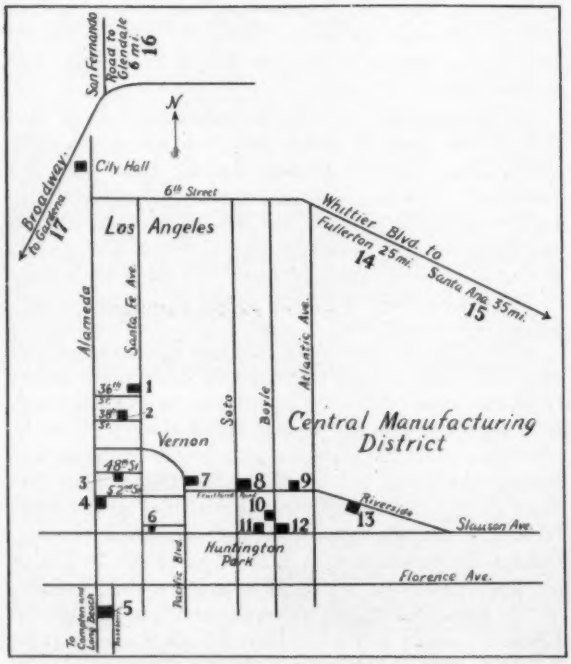
This period, which saw the establishment and develop-



The only sheet glass plant in Southern California, that of the Mississippi Glass Co.

ment of the great Latchford and McLaughlin glass companies, also wrote the final chapter for Southern Glass Co., In 1930, it was taken over by the Owens-Illinois Pacific Coast Glass Co., which closed down the plant and removed the equipment. This brought to an end the story of the plant that had first demonstrated the possibility of bottle-making in Southern California and trained so many glass men for "local experience."

Another graduate of the old Southern Glass Co., Benjamin H. Koons, in 1929 organized the Maywood Glass Co. to manufacture preserve jars and a large variety of flint and amber bottles ranging in size from eight ounce to one gallon capacity. It has one 15 and one 30 ton tank. In addition to semi-automatic equipment, the company operates two feeders under a Hartford-Empire license and the forming equipment consists of one Lynch R, one Lynch LA, one O'Neill and two Teeple Johnson machines.



1. Glass Containers, Inc; 2. Lenwood Specialty; 3. Technical Glass Co; 4. McLaughlin Glass Co; 5. Latchford Glass Co; 6. A. H. Forgar & Co; 8. Owens-Illinois Pacific Coast Co; 11. Columbia Glass Co; 12. Owens-Illinois Pacific Coast Co; 13. Maywood Glass Co; 14. Mississippi Glass Co; 15. Brock Glass Co; 16. Crystalite Products Corporation; 17. Larson Glass Co.

Another branch of the Southern California glass container industry is exemplified by Glass Containers, Inc., which was organized in 1919, a contemporary of the Southern Glass Co. This group began as the Long Beach Glass Co. with a plant in Long Beach but they later erected another plant in Los Angeles where they moved their offices, holding the Long Beach plant in reserve. This plant is devoted exclusively to the manufacture of flint glass bottles and containers for proprietaries, ethicals, beer, liquor, toilet articles and cosmetics. They have a daily capacity of 75 tons from two continuous tanks. Their equipment consists of four Hartford-Empire feeders and the following bottle blowing machines: one Lynch B, three Lynch LA, one Lynch 10 and one Miller press and blow telescopic.

Through a series of absorptions, the Owens-Illinois Glass Co. has succeeded in establishing itself in Southern California as the Owens-Illinois Pacific Coast Glass Co. First, there was the West Coast Glass Co. which was built in 1920 to manufacture hand-pressed and blown wares. Soon, however, the demand for milk bottles absorbed the facilities of this plant which was then sold to the Pacific Coast Glass Co., which in its turn became a unit of the Owens-Illinois Pacific Coast Glass Co. Unlike the Southern Glass Company's plant, this factory continued in operation and today the greater portion of the milk bottles used in the Southwest are said to be made there. This plant recently installed a decorating lehr and other equipment for applying permanent labels and trade-marks on milk bottles.

Window Glass. The story of the window glass business varies somewhat from that of the flint and bottle business in that more than 30 years ago there was established in Stockton an 18 blower plant that was later increased to 36 blower capacity. This plant operated until 1921 when it went the way of all hand plants faced

with the competition of machine factories for producing flat drawn glass.

As a matter of fact, there is only one sheet glass plant operating in Southern California at the present time, that of the Mississippi Glass Co. The reason for the failure of the window glass companies appears to be that while the bottle manufacturer usually lists hundreds of items and the flint glass maker may have thousands of items, the sheet glass manufacturer makes up a few stock sizes from which the dealer cuts his customers' wants. For another thing, sheet glass nests perfectly, thus making possible the packing of considerable quantities in a limited space. Thus economic shipping and storage are facilitated which helps to explain to some extent why the California window glass factories were forced to close down despite the very active market demand during the housing boom in Los Angeles.

The only active plant at present is that of the Mississippi Glass Co. This plant was originally erected in 1924 by the Western Glass Co. and then became a part of the Highland Western Glass Co., before being acquired by Mississippi who also have leased the plant of the Columbia Glass Co. The Mississippi Glass Co. plant has one furnace of 50 ton daily capacity and makes rolled, wire and polished wire glass for building purposes.

To date, no efforts have been made to manufacture plate glass in Southern California, although in 1928 the Pittsburgh Plate Glass Co. bought a 200 acre plot near Santa Ana for the purpose of erecting a plant. However, business conditions have not made this advisable.

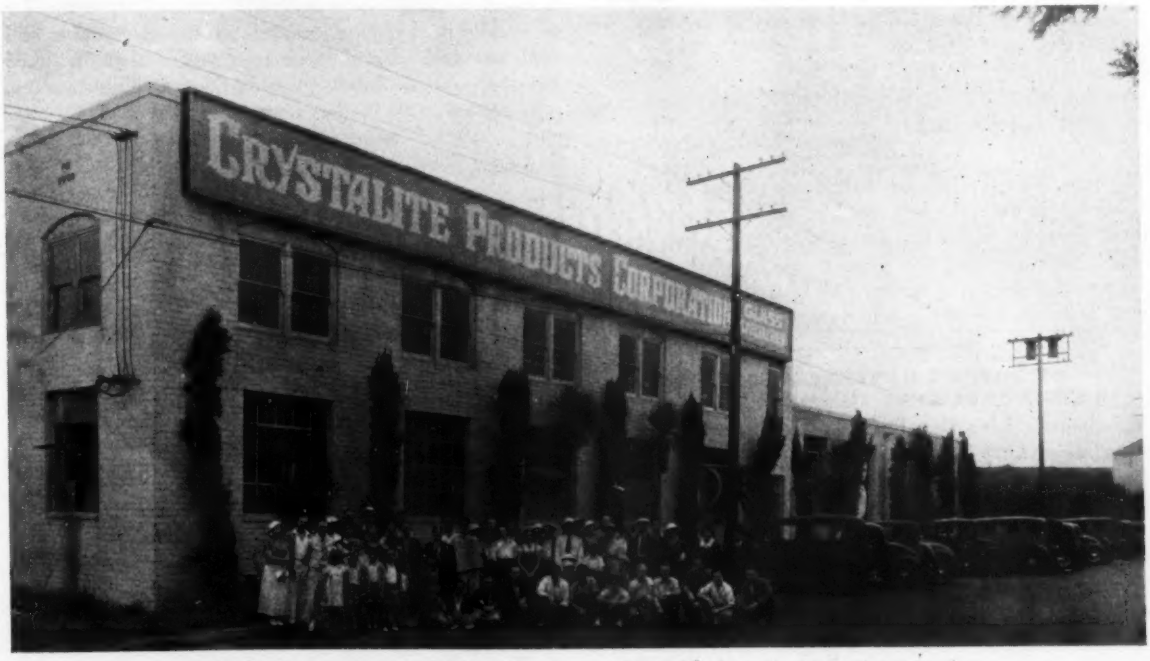
Miscellaneous Glass. In addition to producing glass containers, and some sheet glass, Southern California is also the location of manufacturers of various items made of glass. The Crystalite Products Corporation, for instance, manufacture letters for theatre advertising and lighting units. This company, with five day tanks, manufactures various glass specialties, and private mold work, as well as enclosing globes, under the supervision of Fred Glassen, who it will be recalled was one of the first glass technicians to come to Southern California.

There are various other plants making such specialties as gasoline cylinders, bird baths, residential lighting units, silvered reflectors, ironmold and pastemold and various pressed glass specialties. Among such plants are A. H. Forgar Co., Brock Glass Co., and Larson Glass Co.

One of the most interesting features of the Southern California glass industry is its concentration in a comparatively small centralized territory. Due to trucking, shipping and freight facilities it is found advisable for the industries of Southern California to centralize their activities between Los Angeles and Long Beach. The accompanying map admirably illustrates this condition.

There is still an enormous amount of glass shipped into Southern California for building purposes and household use. But when one considers that 16 years ago the business of glass manufacturing in this district was all but a total loss, the growth and present condition of the industry is remarkable. The bottle and blown containers industry has been developed with a view to an increased population in the future and the development of food and wine industries of Southern California. Certain lines of flint glass have not only been developed to take care of local needs but are shipped all over the world. However, it should be noted that only a small percentage of the tableware and lighting equipment is made in local plants. And in the field of flat glass, only rough rolled and wired glass is made in Southern California.

The 20 odd plants in Southern California employ approximately 1400 people but in normal times would probably require more than 2000. To meet present conditions, some plants have spread employment by working their plants on a four shift basis, while others are operating on a five day week.



Illuminating ware and novelty glass are made by hand at the Crystalite plant.

OWENS-ILLINOIS BUYS LIBBEY

After several months of negotiations, the Owens-Illinois Glass Co. has acquired the Libbey Glass Manufacturing Co. in what is reported to be the biggest business deal in Toledo in several years. The agreement is said to involve some $5,000,000 for which Owens-Illinois will issue 47,200 shares of its common stock for the Libbey assets which are to be acquired free of all liabilities and indebtedness. Terms of the contract provide that Owens-Illinois is to have full benefit of the Libbey 1935 earnings which will constitute net additions to their working capital.

The Libbey Glass Manufacturing Co., which was organized in 1919, succeeded to the assets and business of the Libbey Glass Co. founded in 1888 by the late Edward Drummond Libbey. It was largely in the Libbey plant in Buckeye St. that the Owens bottle machine was developed out of which came the tumbler, as well as other machines that have revolutionized the thin-blown glass industry of the world. During the past few years Libbey has spent some $600,000 in modernization work in producing glassware for hotels, restaurants, clubs and soda fountains, as well as other engraved and decorated glassware. During the last year, Owens-Illinois has been acting as sales agent for Libbey tumblers so that the union of these two great corporations is not an unnatural one.

For the present, it is planned to operate the Libbey plant with the same personnel as a division of Owens-Illinois and not as a subsidiary. The plant employs approximately 1,000 workers under the presidency of Joseph W. Robinson. However, it is expected that over a period of years the Libbey Co. will be liquidated.

"CROWN" OF BALTIMORE TO BUILD?

Crown Cork and Seal Co., Inc., has filed with the Securities Exchange Commission a registration statement projecting a $5,500,000 issue of a 4 per cent 15-year sinking fund bond maturing on Nov. 1, 1950. The company proposes to use the proceeds from sale of the issue for redemption of $4,313,500 of 6 per cent sinking fund bonds due Dec. 1, 1947, and for acquisition or construction of additional property or for improvements of its plant and properties.

The new Richmond (Va.) warehouse of the Pittsburgh Glass Co. is quite the last word in efficiency. Its equipment includes specially designed slotted glass racks, which by permitting the glass to be handled on edge, reduces the chance of bloom and scratches. N. S. Dunning is in charge of the warehouse.

AMERICAN OPTICAL ACQUIRES LARGE INTEREST IN SPENCER LENS

The Spencer Lens Co., Buffalo, N. Y., announces that negotiations have been completed whereby the American Optical Co. has acquired a substantial interest in it. Both companies have been in business for nearly a century and H. N. Ott, president of the Spencer Lens Co., predicts that with the assistance of the American Optical Co., his company will be able to progress rapidly through enlarged manufacturing and development resources. The business of the Spencer Co. will continue to be operated under the same name, policies and personnel, with executive offices and manufacturing plant at Buffalo, N. Y., as at present.

Charles E. McManus, president of the Crown Cork & Seal Co., recently returned from Europe. Accompanied by Mr. Frank Lloyd, he has been attending to important matters connected with the company's expansion.

O-I STILL EXPANDING

Several announcements of general interest to the glass industry were made by president Wm. E. Levis of the Owens-Illinois Glass Co., in the report on the earnings of that company covering the twelve months ending September 30.

Important among these was the information that Owens-Illinois had acquired the assets of the insulating division of the Gustin-Bacon Manufacturing Co., Chicago, who have been manufacturing such products as glass wool and industrial insulation, railroad car insulation and glass wool metal mesh baskets. Valuable patent rights were acquired at the same time to give Owens-Illinois an open road in the development of all types of glass fiber insulation and products.

An arrangement has also been made with the Corning Glass Works by which Corning and Owens-Illinois will cooperate in research and development work in connection with glass fibers. Both companies will concentrate on further developing glass fibers and applying this product to new uses.

All divisions of the company's bottle and package division are reported to have shown improvement. Approximately 20 breweries have adopted the "Stubby" beer bottle and it is said that this bottle will soon be available in all major cities east of the Mississippi.

Net earnings of the Owens-Illinois Glass Co. and subsidiaries for the 12 months period ending Sept. 30, were $7,893,976.23, which compares with $6,085,476.38 for the same twelve month period of the preceding year. In arriving at these earnings, deductions were made for depreciation, depletion, federal taxes, bad accounts and contingencies. These earnings are equivalent to $6.85 per share on the 1,200,000 common shares outstanding, compared with $5.07 for the preceding year. The company's general offices have been moved to the Ohio Building, Toledo, and occupy eight floors.

GLASS COMPANIES FORM JOINT SALES CORPORATION

The Fourco Glass Co., Clarksburg, W. Va., has been newly organized and will act as exclusive sales agents for Adamston Flat Glass Co., and the Rolland Glass Co., both of Clarksburg, as well as for the Blackford Window Glass Co., Vincennes, Ind., and the Scohy Sheet Glass Co., Sistersville, W. Va. An attempted $300,000 merger of the Fourco Glass Co. with the Quertinmont Glass Co., Fairchance, Pa., was delayed by the opposition of minority stockholders.

REPORTS BIG SALES GAINS

Shipments of the Libbey Glass Manufacturing Company for the first nine months of 1935 increased 15 per cent over the corresponding period of 1934, according to an announcement made by John H. Wright, president. In addition, the month of September showed an increase of 17 per cent over the same month last year.

CLEANING PRODUCER GAS LINES

By J. GAVIN CALLINAN

THE periodic cleaning or burning-out of the producer gas lines in the average factory is a dirty, hot and difficult job. Perhaps on that account, it is often neglected by those in charge, with the inevitable results that possible improvements in practice are seldom worked out and the job is left up to the producer men to push through the best they can in the good old way.

Anything that will extend the interval between burn-outs, or shorten the actual cleaning time, is a money saver. During the burn-out a more expensive fuel must be used to keep the tanks in operation, and the changeover sometimes upsets the melting and temperature conditions to such an extent that damage to both the quality of the glass and to production schedules may effect some tanks, for as much as twenty-four hours or more. Besides saving money, reducing the number of burn-outs, speeding them up and making them easier, it saves man power and makes a mean job a bit more pleasant.

Whenever plans are made to save money, an investment of time and cash is required: time, for responsible parties to study the job, plan improvements, and then check performance; money, for tools and facilities to do the job thoroughly, quickly and safely. An investment in good valves, safe steam hose, asbestos gloves, goggles, good pipe unions, tools, pipe for more convenient steam connections, clean-out holes, etc., will show the men that in tackling the burn-out problem, the management means business. However, they should be impressed with the fact that there are *two* objectives in view. Not only is it done to make the job easier for them, but also to reduce factory costs and maintain a consistent glass quality.

Mention should be made here of the value of adequate and safe working platforms. Stout platforms with secure flooring and staunch railings impart a feeling of security that enables the men to keep their minds on their work.

From an operating standpoint, the main objective is to maintain the producer gas line in the best of condition compatible with low burn-out frequency. Three factors among others, influence this: original design of the line, interim clean-outs, and the periodic burn-outs

Design of the Line. Not much need be said here regarding the design of the line. Many of the gas lines now in use are bad from a design standpoint; some because of structural limitations, others because of false economy and lack of knowledge. Well designed dust catchers and soot legs, and plenty of them, with an ample, well-insulated line, mean longer runs between burn-outs.

There are three methods of dust or soot separation: (1) Reduction in gas velocity; (2) Impingement against baffles; (3) Change of direction. By keeping these three methods in mind, the individual can work out a satisfactory design for himself; but it is usually more advisable to take the problem to an expert—to the makers of gas producers themselves.

Interim Clean-outs. Regular clean-outs on a fixed schedule between the burn-outs should be arranged so that as much soot as possible (and tar, if it is collected in any quantities) can be dropped into the soot legs and even removed.

It is important that someone be on hand to inspect the line carefully as soon as the doors are opened for the first step in the burning-out process. This makes possible a ready location of the big deposits that are blocking the line. With this knowledge a fixed routine can be planned to rake or blow these deposits into soot legs every few days. It is well to note that when a line is in operation, blowing the soot may carry it over into the checkers or even into the tank; yet the main danger is that it may merely be piled up somewhere else in the line, possibly in a bigger pile than before. A little checking up on results at the time of the next burn-out will determine this.

In one case, the soot was raked every other day with good results. Rake heads were installed in the line; that is, the head, with about fourteen inches of handle, was always left in the line (Fig. 1). The short handle extending out through a tapered hole had its end threaded so that a longer handle and even an intermediate extension could be attached and with this the soot raked into a convenient soot leg (Fig. 2). Here again, a part of the soot may be picked up and redeposited in the line, perhaps in a more inaccessible place, and this must be looked for at the next burn-out.

When not in use, the head is pulled close to the lining, the handle removed, and the hole clayed tight. A removable pin attached to the short handle can be fixed so that there is no danger of the rake falling into the line should it be dislodged accidentally.

Some lines, especially the header or manifold into which the producer offtakes pass the gas, are equipped with scrapers which can be pulled back and forth by means of a chain. For simplicity however, the rakes mentioned above are preferred.

Rakes are also used in the soot legs, which can be

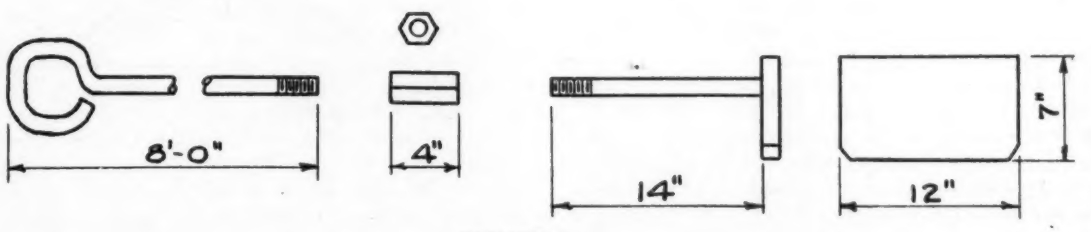


FIGURE 1

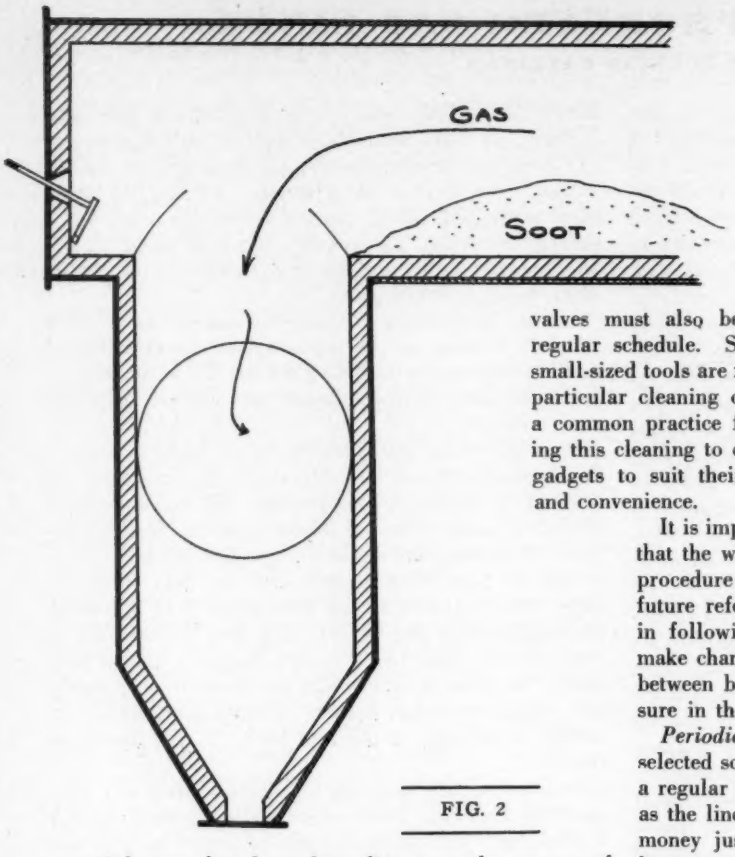


FIG. 2

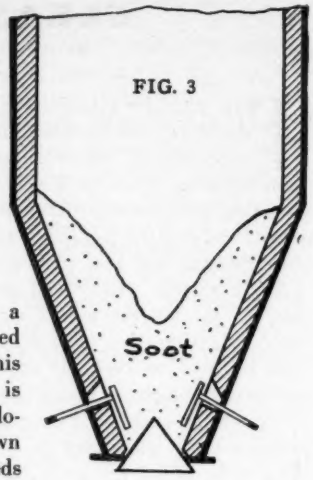


FIG. 3

emptied every few days, depending upon the amount of soot accumulated and the conveniences for its removal. A few pokes with the rake through the side of the leg (Fig. 3), will bring down the soot which adheres to the sides of the soot leg. This is a much more efficient method than pounding on the pipe or poking a rod up through the bottom of the leg. Workers on this raking operation should be required to wear suitable goggles to protect their eyes. The soot which is thus raked can then be dropped into a dump truck or a brick collector house from which it can be shoveled after it has cooled.

All such clean-out work should start at the producers and work towards the tanks, cleaning the gas reversing valves as well. Steam can be used on the valves if necessary, sometimes through built-in steam nozzles as are found in some gas lines.

In addition to providing a free passage for the gas by this cleaning-out process, the valve must be properly balanced and in a free working condition. Plant diplomacy requires that the tank teaser should be notified whenever steam is to be introduced into the gas line. He will be quick to appreciate the advantages of a clean gas valve, as well as to discourage the excessive use of steam during the operation.

Water seals on the reversing valves must also be cleaned on a regular schedule. Specially shaped small-sized tools are required for this particular cleaning operation. It is a common practice for the men doing this cleaning to devise their own gadgets to suit their specific needs and convenience.

It is important in conducting these cleaning operations, that the workers be given a definite plan of step-by-step procedure; not only as a guide but also as a basis for future reference. As a result of the observations made in following these plans, it is frequently necessary to make changes and it may be possible to extend the time between burn-outs without building up too high a pressure in the producers.

Periodic Burn-outs. Burn-outs are best done on days selected some time in advance. During normal operation, a regular schedule can be maintained; although, as long as the line is "free", there is no need to waste time and money just to keep to a schedule. In some cases the burn-out can be coordinated with certain other factory jobs—as, for example, floater changes; since it is usual to make cullet-only fills for both jobs, and machine production can be arranged so as to lessen the pull on the tank. Where fuel changes upset melting conditions very much, it is unwise to change floaters during the burn-out. They may, however, be set shortly before the burn-out so that the new floaters will be in place to catch any material that might come down the tank.

Observant tank teasers and producer operators can tell when the line is about ready for a burn-out. Steam pressure to the jet blowers or bottom pressure on the turbo-blowers climbs up, excessive loss of gas occurs around the coal feeds, the gas supply tends to become

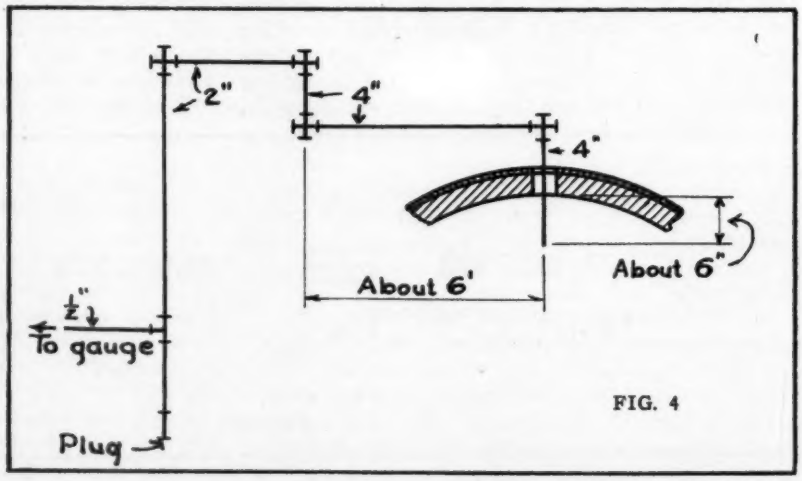


FIG. 4

irregular. All these indicate a sooty line somewhere.

Pressure readings are a helpful guide. If one is careful to make sure that the line connecting the gauge to the gas line is open and not obstructed with tar and soot, then the pressure drop or loss between two points in the line is a handy indication of soot elsewhere in the line. For reliable results a relatively elaborate set-up is required, which must be carefully attended to in order that it be dependable. A 4-inch pipe installation with plenty of pipe crosses is recommended (Fig. 4).

The morning is a good time for the burn-out because it permits certain preparatory jobs to be done by the night shifts. The night producer operator and his helper should have the clay mixed; bars, sledges, and other tools laid out; goggles and asbestos gloves ready, and sand on hand if needed. The tank teaser can have his burners ready and lined up, burner holes cleaned, steam lines drained, and mixed clay mortar and bricks ready for changing any port dampers.

Work schedules should be posted. In one factory a certain tank procedure was worked out that gave the best results during the burn-out. Because considerable time elapsed between burn-outs and because of shift rotation, a written notice refreshed memories. For example, pulling the damper on the fourth port so as to build up a little reserve heat in the refining tank was set for one hour before the burn-out. Then, as soon as the producer gas was off, stack dampers and air valves were immediately set to predetermined openings. After the initial rush was over adjustments were made to suit operating conditions. Instructions as to cullet-only fills, temperatures to hold, when to resume batch fill, etc., all can be listed to advantage.

Likewise, the burn-out crew should have its list or schedule. On one set-up using three producers five men in addition to the two men from the producer department were on the burn-out crew and usually the teaser and the assistant superintendent were on hand to help push the job along as fast as possible. These men were assigned definite jobs resulting in speedy, thorough burn-outs with a minimum of hard work, interference, and waste of time.

This three-producer plant did not have a burn-out stack or other means of disposing of the soot and all gas and soot had to be vented to the air through the clean-out doors.

In the column adjoining are given the instructions used at this plant, which burns out about every four or six weeks, changing over to a fresh gas producer each time.

"Gas Line Burn-outs"

Yates • Start on Dyblie valve.
Neal and *Mall* • Start on soot leg behind tank.
Oliver and *Stanbridge* • Start on producer and work to the following schedule under the instructions of the producer operator.

1. Open all out. Top doors first.
2. Producer men will open damper for producer that is to be put on the line.
3. Burn out top header. Use rakes as much as possible but without wasting time.
4. Burn out producer necks and uptakes.
5. Burn out main line to tank.
6. While No. 5 is under way, producer operator and helper will clean damper slot on producer that is to be taken off the line. Close damper as soon as all work on top header is completed.
7. The first men finished with their jobs are to start to clean the doors, close them, and clay them tight as soon as possible. Start at the top and work down.
8. Producer operator to check the above and then to open all drain valves on his steam line and blower. Have six pounds of steam pressure on. After all water is out of line signal furnace man to put on full steam pressure and then go ahead with gas making. Air gates should be kept closed during the burn-out and only opened after steam is first put on. The above can be started before all doors are closed provided the men are closing the top doors first and working towards the tank. If a fire is dull, do not feed much coal on it.

NOTE: If Dyblie valve gets red hot, have furnace men to reverse. Also close door at bottom of water sealed soot leg immediately.

The above instructions are peculiar to a specific plant but give an idea of what may be worked out to organize a burn-out.

A properly worked out list of preparations and a schedule giving the order in which the operations are to be conducted is of vital importance. It organizes the work in the minds of the men and enables the supervisor to study the procedure of the burn-out as planned, and as executed. Thus it becomes possible to improve the burning-out process and achieve greater efficiency with attendant savings in operating expenses.

NEW STANDARD ACID CONTAINER

A new standard type of glass container has been recommended by the Manufacturing Chemists' Association for the transportation of mineral acids and corrosive liquids. The new standard package is a 13 gallon carboy, designed according to specifications now on file at the Association's Washington headquarters. The report states: The glass carboy is the oldest container used for the transportation of mineral acids and certain corrosive liquids. Its extensive use is attributed to its cheapness, resistance to corrosion and ease of handling.

The adoption of the standard carboy is the result of an extensive investigation that was first undertaken in 1931. A variety of carboys, representing all those commonly used, was first selected for test, and the number eventually reduced to three. Last month, the Association announced its final selection.

AUGUST PLATE GLASS PRODUCTION

Production of polished plate glass by member companies of the Plate Glass Manufacturers Association was 14,404,060 sq. ft. in September, 1935, as compared with 14,526,312 sq. ft. produced in August. This makes a total of 131,202,176 sq. ft. produced during the first nine months of 1935.

MOULD CALCULATIONS

By DONALD A. BRIDGES

A CLOAK of mystery still seems to surround the design of parison and blow moulds for glass bottles and containers, and it has been a considerable source of disappointment to the writer that someone has not written a simple, yet comprehensive, manual on mould design. Conversations with men in the glass industry and observations made in a number of plants show that there is considerable diversity in the methods by which parison and blow moulds are calculated. This diversity exhibits itself in a variety of "factors" and "conversions" of a more or less hit and miss nature. The most striking feature of these factors and conversions is the fact that, in nearly every case they have no real foundation on which to base their existence, other than that they seem to work. As a matter of fact, the principles involved in the calculation of parison and blow moulds are of an elementary mathematical nature.

In the design of parison moulds it is necessary to have some means by which the proper size parison can be determined, having given the weight, finish, and content of a bottle or container. By "size of parison" it is here understood to mean the size of the cavity and not the shape, although the latter is of great importance in the design of successful parison moulds. There are undoubtedly a number of conditions which tend to affect the selection of a particular shaped parison. Among these can be included: the chemical composition and nature of the glass, the temperature at which the glass is "worked", the pressure of the compacting and blowing air, the temperature and pressure of the cooling wind, the speed at which the forming machine is operated, and the general existing factory conditions. At the present time, however, there is no practical method of determining the shape of the parison for a particular bottle or container, other than that which is gained through long experience.

DEVELOPMENT OF GLASS FORMULAE

The basic principle behind the calculation of the size of a parison is that of the Greek philosopher, Archimedes, who, in 250 B.C., stated and demonstrated experimentally that, *when any object is wholly or partially immersed in a liquid it is bouyed up by a force equal to the weight of the displaced liquid.* This principle gives rise to a simple method for comparing the weight of glass with the weight of an equal volume of water—the ratio of these weights being called the *specific gravity* of the glass. Thus (1),

$$\text{Specific Gravity of Glass} = \frac{\text{Weight of Glass}}{\text{Weight of an Equal Volume of Water}}$$

In mould calculations, however, the specific gravity is a rather awkward figure to deal with, so a factor called the *displacement factor* is used instead. Incidentally, this displacement factor is the foundation on which is based practically all of the formulae to be developed in this article. The displacement factor is similar to the specific gravity, but differs from it in that instead of dividing the weight of glass by the weight of the displaced water, the weight of glass is divided by the fluid ounce equivalent of the displaced water or displacement, as it is called. Thus (2),

$$\text{Displacement Factor} = D = \frac{\text{Weight of Glass}}{\text{Displaced Water in Fluid Ounces}}$$

The process of obtaining the displacement factor D, for a given sample of glass, is a comparatively simple matter. First, the sample is weighed, obtaining this value in ounces avoirdupois. Second, the sample is sunk in a displacement tank full of water, catching the overflow or displaced water in a container which has been graduated to read fluid ounces. Third, the two values thus obtained are substituted in equation 2, and the numerical value of the displacement factor D calculated. A glance at Table I will show that this value runs from 2.347 to 2.624, depending upon the chemical composition and specific gravity of the sample. As an average value, 2.545 may be used.

It can readily be seen from equation 2, that the displacement factor D is really the weight of glass per fluid ounce of water; hence, knowing the fluid ounce

TABLE I

CONVERSION FACTORS FOR VARIOUS GLASS

D DISPLACEMENT FACTOR	F RECIPROCAL FACTOR	W WEIGHT FACTOR	C VOLUME FACTOR
AVD. OZ. GLASS / FL. OZ. DISPL. = D	$\frac{1}{D} = F$	D X .554 = W	$\frac{1}{W} = C$
1 FL. OZ. = (D) OZ. GLASS	1 OZ. GLASS = (F) FL. OZ.	1 CU. IN. = (W) OZ. GLASS	1 OZ. GLASS = (C) CU. IN.
FL. OZ. × D = OZ. GL.	OZ. GL. × F = FL. OZ.	CU. IN. × W = OZ. GL.	OZ. GL. × C = CU. IN.
2.624	0.381	1.454	0.688
2.604	0.384	1.443	0.693
2.584	0.387	1.432	0.698
2.577	0.388	1.428	0.700
2.571	0.389	1.424	0.702
2.564	0.390	1.421	0.704
2.557	0.391	1.417	0.706
2.551	0.392	1.413	0.708
√ 2.545	0.393	1.410	0.709
2.538	0.394	1.406	0.711
2.532	0.395	1.403	0.713
2.525	0.396	1.399	0.715
2.519	0.397	1.395	0.717
2.513	0.398	1.392	0.718
2.506	0.399	1.388	0.720
2.500	0.400	1.385	0.722
2.481	0.403	1.374	0.728
2.463	0.406	1.365	0.733
2.445	0.409	1.355	0.738
2.347	0.426	1.300	0.769
FL. OZ. TO OZ. GL.	OZ. GL. TO FL. OZ.	CU. IN. TO OZ. GL.	OZ. GL. TO CU. IN.

displacement of any piece of glass and the corresponding displacement factor D, the weight of the glass in question can be obtained by using the formula (3):

$$\text{Fluid Ounces} \times D = \text{Ounces of Glass}$$

The reciprocal of the displacement factor will obviously result in another constant. This constant is called the *reciprocal factor*. Thus (4),

$$\text{Reciprocal Factor} = F = \frac{1}{D}$$

The F factor is a reciprocal function of the displacement factor D, consequently the former will vary inversely as the latter. Table I shows that the reciprocal factor F will vary from 0.381 to 0.426, with 0.393 being a good average.

Since the F factor is the reciprocal of the displacement factor D, it follows quite naturally that the former becomes the fluid ounce displacement per avoirdupois ounce of glass. Thus we have a convenient tool for finding out what displacement a given weight of glass will have, which is shown by (5):

$$\text{Weight of Glass} \times F = \text{Fluid Ounces}$$

Water, at a given temperature and pressure, will have a fixed volume for each fluid ounce. At standard conditions (62°F., 14.7 lbs. per sq. in.) this relationship becomes—one fluid ounce of water contains 1.80469 cubic inches. For all practical purposes, however, this value is taken to be 1.805, and as the volume of water changes so slightly with changes in temperature and pressure, this value is assumed to be constant. Another important conversion factor for use in glass calculations is thus obtained: knowing or having computed the fluid ounce displacement of any piece of glass, its volume may be found by (6),

$$\text{Fluid Ounces} \times 1.805 = \text{Cubic Inches}$$

Another equally useful formula grows out of the above factor. Since,

$$\frac{1}{1.805} = 0.554$$

which is the fluid ounces contained in one cubic inch, then (7),

$$\text{Cubic Inches} \times 0.554 = \text{Fluid Ounces}$$

There are two other conversion factors that are extremely useful and consist of changing the volume of a piece of glass into its weight in avoirdupois ounces and vice versa. Since there are 0.554 fluid ounces contained in one cubic inch of water, and the displacement factor D represents the weight of glass per fluid ounce displacement, the two values multiplied together will result in a new factor which will be the weight in avoirdupois ounces of one cubic inch of glass. This factor is called the W or *weight factor*. Thus (8),

$$\text{Weight Factor} = W = D \times 0.554$$

Because this factor depends upon the displacement factor D, which in itself is variable, the former, too, will vary. Table I shows the weight factor W to range from 1.300 to 1.454, with 1.410 being a good average to use.

The formula for using this weight factor W is then (9),

$$\text{Cubic Inches} \times W = \text{Ounces of Glass}$$

TABLE II

GLASS CONVERSION FORMULAE

BY MULTIPLICATION

WT. OF GLASS	×	F	= FLUID OUNCES
WT. OF GLASS	×	C	= CUBIC INCHES
FLUID OUNCES	×	D	= OZ. OF GLASS
FLUID OUNCES	×	1.805	= CUBIC INCHES
CUBIC INCHES	×	W	= OZ. OF GLASS
CUBIC INCHES	×	0.554	= FLUID OUNCES

BY DIVISION

WT. OF GLASS	÷	D	= FLUID OUNCES
WT. OF GLASS	÷	W	= CUBIC INCHES
FLUID OUNCES	÷	F	= OZ. OF GLASS
FLUID OUNCES	÷	0.554	= CUBIC INCHES
CUBIC INCHES	÷	C	= OZ. OF GLASS
CUBIC INCHES	÷	1.805	= FLUID OUNCES

(FOR VALUES OF D-F-C & W SEE TABLE I)

As was seen in the previous cases, a reciprocal relationship quite naturally grows out of the weight factor W. In this case the new factor obtained is known as the *volume factor*, and represents the cubic inches contained in one avoirdupois ounce of glass. Thus (10),

$$\text{Volume Factor} = C = \frac{1}{W}$$

This volume factor C is likewise a variable, for it is a function of the weight factor W, which in turn depends upon the displacement factor D, a variable. A glance at Table I will show the range of the volume factor C. For average use, 0.709 may be taken.

The formula for using volume factor C becomes (11),

$$\text{Weight of Glass} \times C = \text{Cubic Inches}$$

All of the factors and conversion formulae necessary in mould calculation have now been developed. For convenience, a recapitulation of these formulae is given in Table II. It is to be noted that this Table also gives a divisional relationship which is, of course, a natural mathematical consequence. Table III has been prepared for use where it is not possible to determine the factors outlined above, it merely being Table II with average numerical values substituted for D, F, W, and C.

TABLE III

CONVERSION TABLE FOR AVERAGE GLASS

WT. OF GLASS	×	0.393	= FLUID OUNCES
WT. OF GLASS	×	0.709	= CUBIC INCHES
FLUID OUNCES	×	2.545	= OZ. OF GLASS
FLUID OUNCES	×	1.805	= CUBIC INCHES
CUBIC INCHES	×	1.410	= OZ. OF GLASS
CUBIC INCHES	×	0.554	= FLUID OUNCES

NEW PYREX CONSTRUCTION UNIT

The Architectural Division of the Corning Glass Works has announced a new construction unit, illustrated here. It has many interesting features. First to be noted is the shape and size. Although the ordinary clay brick has established a standard since time immemorial, Corning engineers found by investigation that this traditional size was not essential. Consequently they arrived at dimensions (11¾ x 11¾ x 4 inches) more in keeping with the functional and aesthetic values of glass.

The unit is partially evacuated. This will reduce heat losses (the loss will be less than through an 8″ brick wall), and by using a low expansion glass, its strength remains extremely high.

The unit is really two units; one backing up the other at right angles to it and completely sealed. The method of sealing is important since by means of it the partial vacuum is created, and a degree of "tightness" is secured that makes internal condensation impossible. Also by placing one face of the unit at right angles to the other, the fluting on one side is horizontal, the other vertical. This prevents distortion of any image seen through it, makes these images obscured and not sharply defined, and diffuses light. This latter consideration has further importance in making it possible for light to focus upon any one point; otherwise it is conceivable that a glass wall might have a dangerous magnifying quality and ignite fires in the building made of Pyrex. The unit is ideal to withstand severe and sudden temperature changes.

K. C. Lyon, a graduate in 1931 of the Department of Ceramic Engineering of the University of Illinois, is employed in the Glass Technology Department of the General Electric Co., Cleveland.

LARGEST SCULPTURAL GLASS PANEL

The world's largest sculptural glass panel was unveiled at Rockefeller Center, New York, the past month. The panel is the work of Attilio Piccirilli and has been installed over the main entrance of the Palazzo d'Italia. It is 16 feet high, 11 feet wide, measures over six inches at its thickest point, and weighs three and a half tons. It is composed of 45 sections of unvarying sizes, the largest weighing 250 pounds.

ORGANIZED LABOR AGAINST CANNED BEER

Organized labor has gone on record as vigorously opposed to the tin can as a container for beer. Vitally concerned lest the beer can make headway and throw hundreds of union men out of work, William Laffey, secretary of the Pittsburgh local, is militant in his plea that all union labor patronize only bottled beer. Mr. Laffey, whose local embraces the brewery, flour, cereal and soft drink workers, recently summed up the situation as follows: "If the workers will extend their cooperation to the members of the Brewery Workers' Union, and only patronize bottled beer, our organization would be in a position to place several thousand men to work in the bottling department. I want you to bear this one thought in mind: three men in the racking room and seven men in the wash-house of a brewery can fill 700 barrels of beer in 8 hours. If that same amount of beer was taken to the bottling department to be filled into glass bottles, the service of 80 men would be required for the same. On the other hand, if you patronize canned beer, many of our members who are now employed in the bottling department would be thrown out of work, for as you will readily understand it only takes four men to operate a canned unit, while it requires from 10 to 15 men on a unit where bottles are used.

"Keep the above in mind and patronize only Bottled Beer, and the Brewery Workers' Union will be able to place some of the men to work who are now walking the streets."

TEXT OF A. F. L. RESOLUTION

At a recent meeting of the executive board of the Union Label Trades Department of the American Federation of Labor, the following resolution was unanimously adopted:

"WHEREAS: Practically all glass beer bottles manufactured throughout the country are made under union conditions, and

"WHEREAS: At the present time the tin can trusts are placing a tin can on the market to be used as a substitute for the glass bottle as a container of beer, and

"WHEREAS: These tin cans are not manufactured by members of Organized Labor under Union conditions, but are the product of cheap labor and unfair manufacturing plants and do not bear a trade Union Label; therefore, be it

"RESOLVED, That the Union Label Trades Department of the American Federation of Labor condemn the use of the tin can instead of the bottle, as a container of beer, and express its disapproval and opposition to the use of non-Union tin cans for beer containers by the breweries and bottlers throughout the country; and call upon all affiliated unions and friends to support the continued use of sanitary containers, such as the glass bottle, for bottling beer, ale, and porter, and which are made under Union conditions and entitled to the use of the Union Label."

GERMAN SYMPOSIUM ON STRENGTH

ON MAY 28, a session of a special division of the German Society of Glass Technology considered the general subject of the mechanical strength of glass at Darmstadt. The report was presented in *Glass Technische Berichte* for July and these papers have been translated and summarized for The GLASS INDUSTRY by Professor Samuel R. Scholes of Alfred University.

The meeting was presided over by Dr. O. Seiling, who read a brief address of welcome and outlined some of the subjects to be covered in the technical papers. He then introduced as the first speaker Dr. A. Thum, Head of the Material Testing Institute of the Technical High School of Darmstadt.

Demands Upon the Strength of Glass and the Recognition of Inherent Faults. By Dr. A. Thum.

Glass is evidently capable of serving in a number of useful fields. There is not enough information about its special qualifications for various new applications which are being found for it. Glass must be shown to be completely suitable as a material for these new purposes and care must be taken that the design of the new apparatus or machine part shall be suited to the intended operation and to the material of which it is to be built. Failures may justly be laid to lack of understanding how to harmonize the three important influences; properties of material, scheme of operation and design.

Observation of these values has resulted in applying newly discovered materials with great success. An example is the use of light alloys in motor cylinders for automobiles and airplanes. Cast iron is contemplated as a material for high-speed crank shafts. Such examples are encouraging to the maker and user of glass who seeks new outlets for his material or new material for engineering purposes.

Its optical properties make glass quite supreme in its particular field. Transparency and refracting power are of special importance. Also very important for chemical and physical apparatus are its resistance to heat, to chemicals and to electricity. Some of these are exceeded by other materials in one instance or another but glass possesses transparency in addition, which makes it very desirable for large-scale chemical apparatus. There is a demand, therefore for glass of high mechanical strength in order that we may utilize fully its important property of transparency so that it may give us a better view of the progress and the mechanism of chemical processes.

The relation between strength values and specific gravity must be considered in the evaluation of glass for industrial purposes. Glass occupies a favorable position in this respect with a specific gravity around 2.5 which makes its relatively low strength as compared with metals appear less unfavorable. The hardness and compressive strength of well annealed glass is not so inferior to metals. Tensile strength and bending strength, however, are disproportionately low and limit the applicability of glass in fields in which the demands are heavy. Glass likewise lacks ductility and toughness and is proverbially brittle and fragile. It is sensitive to sudden variations in cross-section, to surface scratches and cuts of all kinds, and is uncertain when sudden overloads occur, besides being very sensitive to shocks and blows.

These unfavorable qualities in comparison with industrial metals appear in a different light when we consider certain rigid forms as the basis for machine construction because many machines are exposed to changing conditions under which the metals eventually yield. Glass is also superior as regards resistance to corrosion.

Glass admittedly lacks toughness and ductility, but so does cast-iron, which forms 70 to 80 per cent by weight of most of our machines and apparatus instead of the tougher and more solid steel. Recently great stress has been laid upon the behavior of materials in the neighborhood of the plastic limit. This is more important for durability; and attention is called to the utilization of cast-iron for crank shafts and other applications of materials which would have been derided 15 years ago.

If glass possessed ductility it would easily be the most desirable of all technical materials. There are constitutional difficulties in the way of increasing this property but the art of toughening glass is showing astonishing results in the increase of flexibility and of strength bending and torsion. The thermal history of the product has a tremendous influence. It is not always true that a state of complete lack of tension gives the best strength. If the stresses created by disannealing work opposite to the normally occuring demands, the disannealed product may be greatly superior. Heat treating seems to be destined to receive a great deal of attention in the production of glass members for machines or buildings.

Emphasis is laid upon the influence of form on strength. The design of sections must be closely related to the character of the material. Sharp angles must be kept at a minimum; there must be in the entire structure a regular, undistorted, uniform flow of force; the bends must be rolled out and overloaded portions reinforced. Fillets can be provided for the relief of places endangered by indentation. Design can also improve the resistance of glass to blows or shocks. These effects increase with the stiffness of construction. There is required limited stiffness, avoidance of sharp angles, and extensibility.

The Structural Properties of Glasses, as Hindrances to Strength. By Dr. Smekal.

This paper, by Dr. Smekal, director of the Institute for Theoretical Physics of the Martin Luther University, attempts to find the underlying sources of the mechanical strength of glass, and to show the derived possibilities for improvement.

It is unsatisfactory to speak baldly of the mechanical strength of glass. In practice, we have to deal with effects of tension, pressure, bending, shock, scratches, or abrasion, as well as temperature variation. Experimental work has provided indices for each of these methods of attack, quite different, and hard to compare. For example, the compressive strength of glass is from 9 to 25 times its tensile strength. We are a long way from a satisfactory understanding of the relationship between these and other strength measurements. It becomes nec-

essary to find the general trend of these different attacks, to plan an all-embracing study.

As de Freminville and Preston have separately demonstrated, glass breaks always under tension, and the progress of fracture and the character of the broken surface are always of the same sort. Even breakage under compression finally turns out to be tensile fracture. The investigation of tearing strength seems to be the best approach.

Since the effect of shape on the distribution of tension can be calculated from the theory of elasticity, it suffices to measure tensile strength on simple straight rods, of circular section, where the surface conditions are uniform. Specimens are presumably strain-free. Most of the published results are unreliable, either because the glass possessed strain (as in measurements on fibers); or was badly loaded so that bending accompanied tension; or the load was not smoothly applied. Analysis of many careful experiments on well-annealed rods, broken under tension, make the results useful in showing the sources of strength.

The tearing process, following a similar course for any rod, will be described for the simplest case, the round rod. The fracture begins at a point of failure F (Fig. 1), whose location is easily recognizable from the broken surface (Figs. 2 and 3 below).

From this failure point the fracture proceeds, at first at a direction normal to the tension, and it then continues to a limit which depends upon the conditions of the experiment and varies a great deal from specimen to specimen producing a smooth surface or flat panel.* There is now a very definite change in the progress of the fracture, and the test piece usually breaks into three, two of large size meeting at the smooth surface and one of half-moon or crescent-shape breaking out as a wedge from between the other pieces and showing rippled surfaces. If the progress of the fracture along the smooth surface, normal to the pull, carries completely across the test piece before the rippled surface begins to form, there may be two smaller crescents instead of one (Fig. 3). In this event, the ratio of smooth surface of fracture to the entire cross-section will probably be 80 per cent or more.

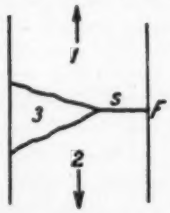


Fig. 1.

Fig. 2.

Fig. 3.

The smooth surface of a fracture might well be expected to extend clear across the specimen were it not for internal inhomogeneity in the glass, which brings it to an end and gives rise to the torn or rippled fracture. Defects of surface of the glass are also held to have an influence on the formation of the smooth surface. It may start from such a defect and end at an internal defect.

The influence of temperature on the ratio of smooth surface to total cross-section has been tabulated, between 190° and 500°C. A minimum occurs at the lowest temperature and maximum values for s/q occur at about 140°, with reduction of smooth areas again at higher temperatures. Fire-polished, scratched rods show similar distributions when the loading rate is high, but much greater areas of smooth surface, at lower loading rate.

The indenting effect of surface irregularities is reduced by smooth acid-etching, with reduction of smooth areas and increase of tensile strength. Matt-etching has a reverse effect. Ordinary scoring or scratching produces a maximum smooth area. Mechanical polishing has a similar effect, because of the multitude of fine scratches produced.

The writer now turns from the particulars of the process of tearing to tearing strength. This is influenced by superficial and internal faults in the glass, the more as these may cause actual notching or indentation. Tabulation of strength values shows that, when the ratio of smooth area to total cross-section at the break is considered in relation to tensile strength, there is an inverse proportionality. It is believed that the problem of tearing strength of glass and its variable values is a problem of internal as well as superficial faults in the glass.

In order to secure the highest possible tensile strength, corresponding to the smallest possible smooth surface of fracture, one can proceed by influencing the internal faults of the glass itself, or the irregularities of surface.

Summary

The fracture of glasses results, after all sorts of mechanical attack, at the place of the greatest tension following, in general, the same course and giving rise to the same sort of fractured surface. The structural influences which reduce the strength of glasses can, accordingly, be investigated with the most all-embracing results on the subject of strength. An important sign of the process of tearing shows that the torn surface, in general, begins at a surface defect, forks in accordance with definite internal faults in the glass, and thereby acquires a certain roughness. The extent of the fractured surface of invisible roughness, the so-called smooth area (Spiegel) is dependent upon the superficial and internal faults as well as the conditions of the experiment. The shrinkings of the smooth area are the prime cause of the manifold variations in values for tensile strength. Another is that only with circular specimens can we place the extent of smooth area in relationship to the total cross-section of fracture, which brings in an important influence of the form of the cross-section upon the distribution of strength values.

The total variation of strength can be shown by means of the variation band of a limited material curve dependent upon the cross-section form and size. The endurance for tension appears to be indicated by the existence of an almost completely smooth, torn surface and therefore it is obtained from the smallest values of the material curve.

The application of the foregoing results to chosen means of attack on chosen non-selected glass objects offers essentially no difficulties.

The possibilities of improvement for tearing strength and the other forms of data on strength rest upon influencing internal faults in the glass, on polishing the outer surface of the glass by etching or fire-polishing,

* "Spiegel"

and on improving by disannealing. Influencing of the internal faults of the glass has not so far been investigated, technically. The greatest increases in strength are possible by systematically combining surface-polishing and disannealing. It has been shown that the optimum increase in strength by disannealing for drawn round rods and for flat glass under the most general hypothesis can be calculated.

Strength of Glass for Building Purposes. Conditions for Measuring Strength and for Utilizing the Results. By Prof. Otto Graf, Stuttgart.

When we addressed your society for the first time in the year 1924 and repeatedly after on the mechanical strength of glass[1] there were two questions in particular that were attacked which strike me as being very important and which are repeatedly asked by the building engineer as well as by the architect: namely; first, how great is the bending strength of flat-glass, that is of window glass, rolled glass, mirror glass, and drawn glass, under practical conditions; and second, through what methods of testing could the most important properties of flat-glass be so definitely expressed numerically that applying the results under practical conditions could be made thoroughly feasible.

In what follows I shall summarize briefly what may be brought forward in answer to the two questions and I shall also discuss what in my opinion still remains to be found out.

In the first experiment there were compared with window glass, rolled glass, mirror glass, and wire glass; first with specimens of the same sheet, then with specimens of the different sheets of the same manufacturer, also with specimens of sheets of different manufacturers. One could thus discover whether differences arising would be great or small. This was necessary because formerly, for the first time in 1924, only very few values for the strength of plate glass were established, and these few dated back to 1890 and 1892.

Bending space was found to be the means of numerous experiments (test pieces 20cm. wide, supports 30cm apart) with window glass 447kg. per square cm; rolled glass 384; mirror glass 380; wire glass 313. Finally values for pieces from the same sheet showed definite differences. The differences were still more noticeable with plates of different manufacture. Table 1 shows these differences for wire glass.

TABLE 1—Bending Strength of 10 cm. wide specimen of plate glass (kg. per cm.^{2})

Sheet	Maximum Value	Minimum Value	Mean Value
Ad 7	568	415	495
Cd 7b	424	285	359
Gd 7	669	393	580
Edb	435	273	346
Edc	457	309	399

At first this data was regarded as somewhat unalterable. Up until now we have not had sufficient vision to let these differences become smaller, but under present circumstances it seems to be necessary to bring every result into agreement and to demand of those interested that they establish the bending strength that really belongs to a given plate glass.

If one follows such a research it is to be observed that the size of the specimen, the preparation of supports, and the conditions of loading, influence the bending strength. It was found in the first experiment that the size of the desired piece was of special importance, see Table 2.

TABLE 2—The Influence of size of the specimen on the bending strength of plate glass.

B	40	20	10	5 cm.
L	75	30	15	7.5 cm.
Kb (mean)	216	366	404	485 kg./cm.^{2}

Corresponding to the relative number for KB 1, 1.7, 1.9, 2.2.

These series of numbers show that, for practical purposes, numerical values that are applicable, with the exception of the bending strength of glasses, are only to be obtained upon large specimens.

Strength-Testing of Flat Glass. By E. Albrecht, Berlin.

The choice of Mechanical Strength as a subject for the general session of the German Society of Glass Technology is an indication of the fundamental importance of this matter. We may expect from such a conference that the subject will not only be fully discussed, but that several practical proposals will be advanced for approval and adoption.

In this frame of mind the present portion of the subject is taken up; and it will be shown, how a few typical procedures can be shaped up, from an almost bewildering array of possible testing methods. Were these generally adopted, we should have, in a reasonable time, adequate numerical values to serve as guarantees for the mechanical strength of all sorts of flat glass. Thereby information as to the value of German flat glass would be broadened and deepened, and confidence in the ware, on the part of manufacturer, dealer, and buyer, would be strengthened.

That the testing of flat glass hitherto has been conducted neither as routine factory-control nor as deterioration testing, may be laid to the fact that the numerical values which one obtains depend essentially on the method employed in carrying out the tests. Obviously, it will not do to speak simply of the mechanical strength of flat glass, but one must differentiate, according to the approach, between different strengths; for example, bending strength, impact strength, etc. For each method of approach, different styles of loading must be distinguished—distributed load, one or more single loads of different form—and finally, during the course of the experiment a whole series of methods of support and of stressing will be applied. Figs. 1 and 2 (p. 348) show methods of loading and supporting, in an elementary fashion, not exhaustively. At least 50 different combinations can be arranged from the set-ups shown, meaning as many possible experimental methods—numbers of these have been applied—for each method of attack.

[1] Glastechn Ber. **3**, p. 153.
Glastechn Ber. **6**, p. 582.
Glastechn Ber. **5**, p. 228.
Die Glasindustrie **36**, p. 191.
Die Glasindustrie **6**, p. 158.

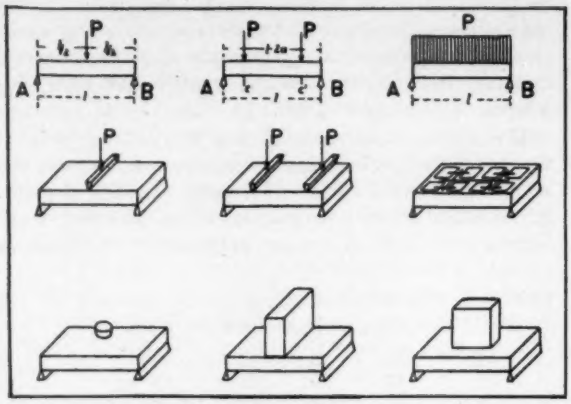


Fig. 1. Typical varieties of loading in Testing Flat Glass. (Albrecht).

As long as we consider the strength of flat-glass only from the viewpoint of building construction, we can limit ourselves in general to static methods (bending, torsion). But when we bring into the field of observation flat glass for vehicles, land, water, or air, dynamic methods also become important. To name some of these: a thrust or blow against the surface or a corner; vibration and testing by pressure-waves (air-pressure-waves from explosions, sustained by windows of buildings, or pressure-waves in water, encountered by port-lights in ships). Dynamic tests are seriously complicated by static stresses, which may be caused by local forces or distributed loading (wind-pressure).

These considerations may suffice to show how incomplete our present information on the strength of flat glass is, without mentioning the well-known, universal dependence of strength-values on size, surface-relationships, and thickness of the specimens. Especially when, as lately, many instead of a few investigators busy themselves with such questions, a unified point of view is not attained. It is a logical consequence of encyclopaedic endeavors, that each separate effort runs farther afield.

Otherwise disposed, and to anticipate, the resolvable problem arises, if we may not set out and study the question from another angle; to separate out from the multitude of possible tests, those of fundamental importance, because they lay hold of the mechanical properties which every manufacturer should be able really to know and announce for his glass.

The selection must go outside of practice and accordingly consider a series of points of view. The special case is not important, but the daily occurrence is, because it is the most common. The attack, to which flat glass is most commonly exposed, is that imposed by an equally distributed, quiet, persistent load. Examples are pressures of wind, snow, and water. The results must be applicable to the construction of buildings, receptacles, or vehicles; therefore, they must not be determined on too small specimens. The equipment must be simple. Material outlay and cost of testing must remain within reasonable limits.

These requirements contradict each other in part. Therefore, they cannot be fulfilled by a single test-method, but nicely by two. The first of these is the fundamental one, that would be carried out only once a year for each variety and thickness of glass; and the other would be a derived test, inexpensive and therefore routine, like the notch-strike-bending test (Kerbschlagbiegeprobe) in steel-manufacture.

1. Endurance-bending test, with uniformly distributed load. Specimen about 1 m², lying free, supported on all edges.

2. Bending strength on specimens about 20 x 40 cm. The specimen lies on two knife-edges, with the load on a third knife-edge in the center.

Procedure (1) gives empirically somewhat low values, the minimum to be reckoned with; procedure (2) gives much higher values. Therefore, the relation between the results of the two procedures must be known. This will appear, as soon as both procedures come into common use, specific for each variety of glass, and will become better established through repeated experiment.

The present condition is, that the static bending strength of flat glass is really known only as a maximum. We are still far from being able to say what value will be reached, for example, in a section of raw glass, and whether a single observation will differ markedly from it.

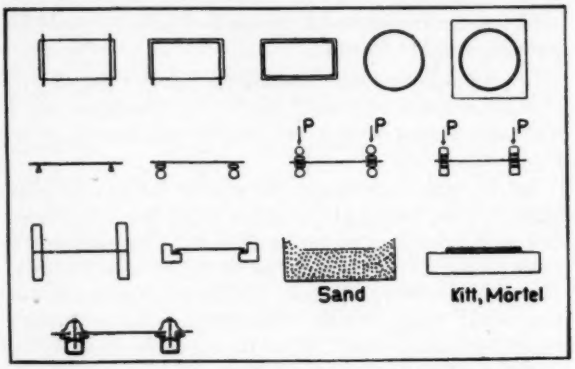


Fig. 2. Supports and Stresses in Testing Flat Glass.

It would be very desirable, however, if such values stood at our disposal, and if, building upon these, guarantees could be given for certain minimum values for the bending strength of single kinds of flat glass. Each giving of a guarantee raises the confidence, not only of the manufacturer, but above all of the consumer, in the excellence of the ware; and accordingly sales increase, especially with skillful utilization of sales-engineering.

For one product a guarantee of this sort has already been given. A certain one-layer safety glass* for vehicles is tested for a bending load of not less than 1600 kg/cm² before it undergoes the falling-ball test. If it is possible to specify such a value for a product whose manufacture is more difficult than that of ordinary glass, why should it be impossible to set up corresponding guarantees for the latter also?

Summary

The strength-testing of flat glass offers a great number of separate problems, since it is not possible to speak simply of strength, but only—according to the kind of attack—of a definite strength, for example bending strength. Moreover, beside the kind of attack, the loading, setting, and tension, etc., influence the results.

Not the carrying out of all possibilities, but the evalu-

* Normblattentwurf. DIN DVM 2303 *Glastechn. Ber.* 1935 p. 95.

ation of a few experimental methods, which will comprise a few important lines of attack, will therefore be regarded as necessary.

Two methods are mentioned, giving average values, limits of failure, and minimum values.

The Conduct of Glass Upon Mechanical Working of a Special Sort. By B. Kindt, Weisswasser.

A new process of glassworking with hard metal-working tools attacks the material, glass, in more than passing fashion. The degree of attack has been hitherto only empirically determined. In a series of examples it is shown, without great error what the glass of today can be expected to stand. The possibilities of form-giving (lathe-working, shaping) in operation and practice open the vision of being able to recognize a scientific foundation for the empirically learned results. It appears applicable and rich in promise. With the application of tools made of especially hard alloys, example—"*widia*", glass is being turned in lathes, drilled, milled and otherwise machined very much as metals would be.

The Strength of Disannealed Flat Glass

L. von Reis, Hergogenrath, writes enthusiastically about the possibilities of improving the strength of flat glass by disannealing. The gain in strength over ordinary annealed glass is placed at 4 to 6 times.

The Status of Foreign Investigations on the Strength of Glass. By M. Wurges, Drannstat.

This is a review of the literature published in England and America on the general subject of strength of glass. The articles cited do not bear dates earlier than 1921 and are to be found for the most part in the *Journal* of the *Society of Glass Technology* and the *Journal* of the *American Ceramic Society*.

Studies on the Strength of Hollow Ware with Special Attention to Endurance. By Dr. K. H. Borchard, Porta Westfalica.

A step to broadening the field of application of glass and toward the improvement of the manufacture is the development of certain testing processes and the knowledge of the dependence of the properties upon the different conditions necessary. In what follows there will be set forth a part of my long continued investigations on the strength of bottles very briefly.

1. The usual short-time strength testing of bottles is not very satisfactory for the result is dependent upon strain, temperature of the experiment, speed of loading, length of loading, number of trials, etc.

2. The variation requires 10-30 trials for the determination of a value for breaking strength.

3. The neck strain is to be given attention over the bottom strain. The effect of strain must be considered in strength measurements.

4. Strength goes down with increase of temperature. (Pasteurization in bottles: the temperature is to be considered in strain measurements).

5. With increasing velocity of loading, the measured result mounts. In breakage testing, statements about increase of pressure are to be added to the measured values.

6. The strength F falls off with increasing duration of loading H, according to a law of the form: $F = a\text{-}b \times \log H$, in which a and b are coefficients. The strength-time curve goes asymptotically, according to a constant independent of time, describing endurance strength.

7. The practical endurance strength reaches (with the bottles investigated) about 40-50 per cent of the breaking strength, even though the properties of the bottles differ greatly from each other.

8. The results of a simple determination of strength have been described.

9. For routine production control there suffices a one-hour loading at 10 atmospheres. A shortening of the testing at once requires a corresponding rise in the testing pressure.

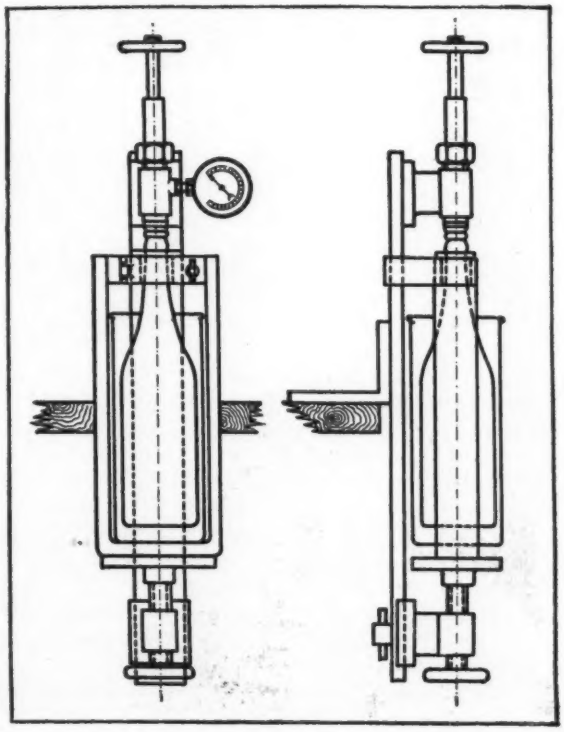
10. As to the influence of the properties on strength, we have already published in *Glastech. Ber.*

11. The same suffices for breakage tests on bottles.

12. For practical production control there have been, besides the disclosed test apparatus, recently a more extended construction. Figs. 1 and 2 show one kind of testing arrangement (patented) which, according to the desire of the experimenter, is supplied with a tension mechanism which furnishes an especially rapid and safe tension. The disclosed construction portrays neck-ring clamps. If one is partial to the bottom tension, the apparatus may be simplified and cheapened further.

13. It seems necessary, especially, to pursue further the following consideration:

a. Dependence of strength on the form of the loading curve (important for comparison with the strength values measured with different apparatus).
b. Influence of form or shape on bottle strength.
c. The strength against localized applied forces.
d. The tension condition of the bottles under internal pressure, the theory of the progress of fracture, etc.
e. Increasing the strength after consideration of the established facts.



Figs. 1 and 2. Bottle Testers. (Borchard).

HARTFORD-EMPIRE EXPLAINS GLASSMAKING AT CONNECTICUT EXPOSITION

A large industrial exposition of extraordinarily successful character was held from October 2nd to 12th in the State Armory at Hartford in connection with the Tercentenary of the founding of the State of Connecticut. The exposition was entirely non-competitive. No direct advertising was permitted, not even to the extent of individual company names, although standardized official signs covering manufacturers by class groups were shown.

Practically every type of product made in Connecticut factories was exhibited, ranging from rayon cloth to airplane motors. In many instances the exhibits comprised actual machinery in production, contrasting the earlier with the new.

Connecticut-built machinery has long been known as second to none in ingenuity, precision and interchangeability. An interesting detail of this exposition and one which, without doubt, contributed much along these very lines, was the actual original milling machine, for metal, built by Eli Whitney, well-known inventor of the cotton gin, and commonly regarded as the originator of the factory, or mass production system.

Contrasting with this early device, and placed next to it, was an exhibit by the Hartford-Empire Company, intended to give those unfamiliar with the process a general idea of how Connecticut-built machinery is used in the production of hollow glassware throughout the world. The Hartford-Empire exhibit included a large process diagram supplemented by photographs of their full automatic feeders, forming machines and lehrs. Typical batch ingredients were shown in correct proportion. There were also bottle forming molds, and a group of seventeen bottles and jars made on the Hartford-Empire I-S Forming Machine, ranging from tiny perfumes up to gallon packers, in blue, flint and amber.

Hundreds of thousands of persons attended this exposition.

GLASS IN HISTORY

"The Role of Glass in History" is the title of an extremely interesting article which appeared in *The Christian Science Monitor* for October 14. There is much of romance in this story which begins with the ancient Egyptians who were the first to make the "trade of imitation stones" a paying proposition. One amusing tale is gathered from that old Roman historian Herodotus who reports that the Egyptians put colored glass earrings on their crocodiles.

The article closes with unconscious irony when it says: "But what brings Bohemian glass home to us in America is not only the famous glass flowers in the Peabody Museum, Cambridge, Mass., but the fact that in our shop windows are displayed the descendants of this older glass, from the same wooded valleys, tagged with the now familiar label, 'Made in Czechoslovakia.'"

One of our correspondents who is now in Mexico City on vacation writes that practically all of the new residences in Mexico City are being designed in the ultra modern style of architecture, with large areas of plate glass being used. Each home has at least one or two stained glass windows.

Hartford Empire Company's exhibit of hollow glassware manufacture at the Connecticut Exposition.

THE THURINGIAN GLASS INDUSTRY*

By DAVID H. BUFFUM
American Vice Consul

THE Thuringian glass industry is most decidedly among those German industries which have been placed in a particularly precarious position by the world economic crisis and is at present laboring under extreme difficulties. This is attributable very largely to the fact that it is one of the principal German industries which has in normal times an export quota of from 50 to 60 per cent of its total production. It is therefore quite evident that the existent low ebb of international trade, the adoption of import quota systems on the part of many countries, the depreciation of the leading currencies of the world, the erection of unsurmountable tariff barriers and similar obstacles in the path of free exchange of commodities have had a disastrous effect upon the Thuringian glass industry which was formerly of very important significance from a national standpoint. The severity of the situation has been rendered more acute through the fact that the domestic market for this industry has been very adversely affected by the low purchasing power of the German people and by the generally low level of industrial activity coincident with the economic crisis in Germany during the course of the last three or four years. A slight improvement with regard to the domestic market has been felt since the middle of 1934, but in the course of an investigation at the centers of glass production in Thuringia, it was apparent that this domestic upward trend has done very little to mitigate a critical situation and that the ominous shrinkage of exports is being viewed with mounting alarm.

The Thuringian hollow glass industry includes a very comprehensive range of products and naturally conditions vary somewhat in the different branches. Although it is unquestionable that certain branches are at an unprecedentedly low level, there are others that are reported to be in an appreciably better position than was the case two or three years ago. For instance, there have been recent indications to the effect that a quite tangible improvement has been had in the thermos bottle industry, which is one of the branches most affected by the depression, in that for several years the world ceased to buy articles even remotely associated with luxury. Another branch of Thuringian glass industry that has recently reported better business results comprises the manufacturers of chemical-pharmaceutical apparatus. Other lines of the glass industry, such as the manufacture of thermometers, pearls and beads, artificial eyes, Christmas tree ornaments and electric light bulbs publish much less optimistic reports.

Apparently continuously decreasing exports constitute the salient reason for the present unsatisfactory conditions in most branches of the glass industry. Many Thuringian glass manufacturers interviewed complain about very keen competition on the world markets caused by numerous glass articles manufactured in Japan which are being supplied at such incredibly low prices that foreign buyers are taking them readily, oftentimes in spite of the fact that they are admittedly of inferior quality. This is of course in keeping with the prevalent trend to buy at the lowest possible figures irrespective of quality and workmanship. Only those branches of the Thuringian glass industry that have been producing specialized articles requiring an especially high degree of skill and long traditional experience, such as the manufacture of artificial eyes, scientific appliances and precision instruments necessitating fine quality materials, are less affected by Japanese competition.

LIMITING MACHINERY NO CURE FOR UNEMPLOYMENT

That part of the glass industry that is confined to the Thuringian Mountains still retains many primitive features, for a high percentage of the production is performed by hand labor in small home workshops and in many instances tools and methods resorted to do not differ materially from those employed in the Middle Ages when the industry was first introduced into Thuringia from Bohemia and Venice. Keen competition abroad and dwindling exports have caused a great deal of distress among such hand workers, most of whom have been inclined to attribute all their woes to the advent of machinery and recently there has been considerable agitation in the mountainous districts advocating the abolition of all glass-blowing machinery in the chemical-pharmaceutical glass industry, in which manual labor was employed exclusively up until a few years ago.

In response to rather frantic appeals for relief, the Government of the State of Thuringia adopted extreme measures in June, 1933, by issuing a series of decrees limiting the use of machinery in certain glass industries, on the theory that unemployment and attendant discontent would be reduced thereby. Presumably these decrees were based upon the assumption that the employment of machinery for lowering the cost of production in certain branches of the glass industry has tended to impair, rather than to improve, the economic welfare of the general population dependent upon that industry, with little or no apparent consideration of the fact that in all likelihood it is machine production in competitive countries that is depriving them of their livelihood. In view of the propaganda features in the preamble to each decree, to the experimental character of some of the measures and the wide departure from business logic, many business men at the time felt that they were dictated more by political than by economic considerations. In the course of an investigation throughout the glass producing districts of Thuringia, it has been ascertained that although these decrees have not been actually revoked, they are being disregarded almost entirely by virtue of the fact that they have been found to be devoid of practicability. It is understood that the only restrictions with reference to the installation of new machinery and apparatus that are being applied at present, pertain to the manufacture of ampoules.

The glass industry occupies a very important position in the economic structure of Thuringia and normally

*Released for publication in THE GLASS INDUSTRY through the courtesy of the Bureau of Foreign and Domestic Commerce, Specialties Division.

furnishes employment for about 17,000 persons. In all of Germany there are at present 500 factories working hollow glass into a very wide variety of glass instruments and apparatus, thermometers, chemical-pharmaceutical glassware, etc. the high bulk of which are concentrated in Thuringia, where there are 430 enterprises which could be considered of factory proportions. At present about 4,000 persons are being employed in Thuringian glass factories, and it is estimated by those in close touch with the trade that from 3,000 to 4,000 receive employment in about 1,200 home workshops. There are 40 glass foundries in Thuringia normally employing 6,000 workers. Only 30 of these foundries are in operation with payrolls that would not exceed 4,000.

THERE is such an extensive variety of articles produced in the glass industry, a great many of which command slightly different wages, that it is impossible to obtain an accurate wage scale. It is stated by industrial leaders, however, that general wages in the glass industry would not exceed the very low average of 30 marks a week. Wages paid in the glass industry in the Thuringian Mountains, including the districts of Ilmenau, Altenfeld and Lauscha, have always constituted the lowest remuneration in the whole German glass industry, but wages now received are stated to be lower than at any time in the recorded history of the industry. There are several contributive factors for the relatively low level of wages in Thuringia, perhaps chief among them being the fact that a large proportion of the finished products emanate from small home workshops. As the home workshop is not a factory, and the skilled home worker is generally an independent artisan, assisted as occasion arises by members of his family, he is not, generally speaking, an employer of labor, and formerly was not subjected to statutory charges for unemployment insurance and similar social services, nor to legal control over the hours of labor in his workshop.

A great many workers in the Thuringian forest, although possessed with a very high degree of skill and talent passed down through the centuries, are endowed with very little business ability, with the result that they have been ill prepared for the world depression that has deprived them of their erstwhile markets. Exploitation of such workers has been frequent in the past, and a great many sales have been made at an exceedingly slender margin over cost of production. With the inauguration of machine units in several branches of the industry, displaced laborers have frequently opened up small workshops of their own and, in order to live, have been glad to accept remuneration considerably under that which they would have been entitled to in a factory. All of which has tended to cause an unhealthy type of competition within the industry.

At present the glass factories in Thuringia are working on a reduced basis of 36 hours a week. It is understood that in the home workshops workmen are not averaging at this time more than 24 hours a week. In the home workshops the operators generally work 12 hours at a stretch when they have work, which is apt to come in irregularly. It is now prohibited to work either factories or home workshops between 6 P. M. and 6 A. M.

Among the chief products of the hollow glass foundries are tubes, funnels, lighting globes, thermos bottles, and

German Exports of Glassware for Lighting Fixtures

Country	1932 Metric Tons	1932 1000 Marks	1933 Metric Tons	1933 1000 Marks	1934 Metric Tons	1934 1000 Marks
Austria	77.2	118	65.8	86	49.4	70
Belgium	180.2	205	238.8	226	187.1	180
Bulgaria			6.8	8	22.6	30
Czechoslovakia	39.8	83	5.5	25	7.5	11
Denmark	168.0	219	237.3	281	321.7	353
Finland						
France	437.2	574	349.9	457	187.0	239
Great Britain	2778.5	2402	3182.4	2564	2476.9	9117
Greece	8.0	28			28.4	48
Hungary	82.2	98	24.3	25	56.3	66
Ireland	200.8	149	107.0	78	153.4	123
Italy	860.7	801	953.8	864	806.1	743
Latvia						
Lithuania	60.9	40	34.3	25		
Luxemburg	4.1	9	6.8	10	9.2	14
Netherlands	680.8	612	710.9	569	460.6	430
Norway	39.9	81	41.9	84	44.5	74
Roumania	37.8	48	34.6	50	37.2	47
Russia	0.8	14			1.3	52
Saar District	45.7	70	38.4	54	74.8	99
Spain	37.6	83	39.9	86	50.6	97
Sweden	91.9	190	88.8	177	98.8	194
Switzerland	261.3	340	278.1	353	231.7	302
Yugoslavia						
Brit. West Africa	58.4	40	63.4	46	52.3	33
Egypt	112.1	121	95.9	108	120.7	115
French West Africa	24.2	18			19.2	15
Irac (Syria Libanon)					46.1	22
Palestine			4.9	13	23.8	27
Persia	36.2	23			20.3	14
Turkey	128.1	101	187.9	137	120.5	90
Union South Afr.	73.2	88	62.4	49	89.4	88
British Indies	251.5	325	201.1	245	172.1	245
Brit. Malay						
Ceylon	29.2	35			15.1	15
China	21.8	48	14.4	21	3.2	18
Dutch Indies	12.2	28	5.1	17	12.0	31
Japan						
Siam	19.3	22	13.7	17	11.1	12
Other Asia	67.7	50	39.8	25	33.7	22
United States	736.5	601	585.7	426	48.0	45
Canada	149.8	141	125.0	86	159.5	97
Argentina	15.7	40	19.9	45	31.2	57
Brazil			7.8	24		
Chile						
Cuba						
Mexico						
Peru					15.4	13
Philippine Islands	14.3	17				
Uruguay	13.3	14	16.3	14	21.1	17
Other Brit. Amer.	43.7	41	68.8	55	65.7	46
Comm. Australia					12.4	13
New Zealand			15.8	11		
All Other	204.2	388	253.2	408	249.9	398
Total	8104.8	8305	8226.4	7769	6647.8	6722

glass vessels of various kinds. Foundries in Ilmenau, Schmiedefeld, and several other towns in Thuringia, produe the tubing used in the manufacture of thermometers and glass instruments, a branch of the industry that is concentrated in that region. The term "glass instruments" is an exceedingly elastic one in that under this category thousands of different articles are manufactured. Other glassworks in Thuringia manufacture various articles such as globes for lighting fixtures, perfume bottles, vacuum flasks, medicine phials, etc.

LOCATION OF SPECIALIZED BRANCHES

The hollow glass industry of Germany is centered in the heart of the Thuringian forest, principally in the mountainous districts of Ilmenau, Altenfeld and Lauscha. Raw glass production in the Ilmenau district consists chiefly of tubing for the glass blowers using the enameling lamp and fashioning therefrom laboratory glass, thermometers, glass instruments and apparatus, and

vacuum flasks. Ilmenau is the distributing center for the various branches of the Thuringian hollow glass industry. In this region are manufactured innumerable kinds and types of chemical, medical, surgical and meteorological instruments and apparatus. Certain factories in Ilmenau, Schmiedefeld and other hill towns in the immediate vicinity specialize in the production of thermometers, glass instruments and apparatus, such as syringes, electrical vacuum tubes, radiometers, spectrum tubes, inhalation apparatus, and precision instruments.

In the Altenfeld district is centered the manufacture of vacuum flasks, perfume bottles, ampoules, glass containers for packing, pills, tablets, lozenges, etc., as well as numerous chemical-pharmaceutical appliances.

German Exports of Glass Instruments and Apparatus

Country	1932		1933		1934	
	Metric Tons	1000 Marks	Metric Tons	1000 Marks	Metric Tons	1000 Marks
Austria	77.1	253	83.0	223	65.3	251
Belgium	69.3	258	80.5	274	69.6	281
Bulgaria	8.3	40	9.2	46	15.5	71
Czechoslovakia	105.0	380	101.2	351	93.6	331
Denmark	55.7	262	82.8	389	84.7	390
Finland	9.8	72	14.5	81	15.4	93
France	47.3	345	69.0	374	55.7	361
Great Britain	214.3	688	252.4	860	268.2	837
Greece	22.9	114	41.4	169	39.4	192
Hungary	158.5	391	124.0	363	85.3	330
Ireland	5.1	27	5.1	27	5.3	31
Italy	246.5	624	254.8	672	249.3	576
Latvia	7.4	48	10.4	69	9.2	65
Lithuania	7.1	49	8.9	56	9.5	55
Luxemburg	3.1	17	3.6	17	3.0	14
Netherlands	159.8	632	185.6	645	192.6	653
Norway	28.3	145	36.5	140	42.2	169
Poland	19.9	147	22.4	141	42.6	214
Portugal	17.3	92	28.3	147	21.2	120
Roumania	44.7	441	47.0	230	74.1	340
Russia	13.8	236	1.4	23	0.7	10
Saar District	4.2	29	6.4	34	7.6	36
Spain	82.8	372	131.2	499	133.8	489
Sweden	83.4	373	112.4	426	111.7	424
Switzerland	162.0	739	172.8	754	212.3	804
Yugoslavia	32.8	178	27.6	120	21.0	103
Egypt	20.7	99	21.3	92	30.6	109
French Africa			0.7	6	1.6	7
Irac (Syria Libanon)					2.3	10
Palestine	2.9	14	6.3	24	5.1	26
Persia			6.6	27	7.1	32
Turkey	18.4	93	30.9	123	31.2	144
Union South Afr.	20.9	99	19.6	87	22.3	93
Brit. Indies	109.0	429	109.2	423	101.2	405
China	36.2	190	46.9	244	43.1	188
Dutch Indies	16.0	80	29.0	94	21.5	77
Japan	2.9	71			1.2	47
Siam	3.1	15	5.6	28	2.5	15
United States	250.0	1350	274.5	1264	134.7	614
Canada	48.8	239	59.0	248	50.9	193
Argentina	39.2	181	66.1	244	66.1	235
Brazil	101.3	430	183.2	725	122.9	585
Chile	9.7	65	4.5	28	8.2	52
Columbia	5.4	56	22.8	101	15.5	105
Cuba	21.9	100	27.0	106	40.0	153
Mexico	33.1	178	43.2	226	37.2	198
Peru	10.1	59	5.7	31	10.2	50
Phil. Islands	7.2	27	9.1	35	3.9	19
Uruguay	13.1	53	15.0	55	17.5	70
Venezuela	4.2	38	4.2	29	6.9	56
Comm. Australia	25.7	109	31.4	128	30.2	139
New Zealand	2.3	13	4.5	23	3.1	17
Danzig	5.8	29	4.5	25	4.1	30
Esthonia	5.1	36	4.6	25	3.9	29
Total	2518.2	11127	2971.6	11720	2768.5	11035

The production of Christmas tree ornaments, dolls' eyes, artificial human and animal eyes, glass toys, marbles, pearls and beads, spun glass, glass flowers and fruits, is concentrated in the Lauscha area. The manufacture of most of these finished products is very closely associated with the toy industry, which is another important Thuringian forest industry carried on to a large extent by home workers in the mountainous towns and villages, notably in Sonneberg and Lauscha.

In keeping with recent measures, there has been a general reorganization of the German glass industry according to the various branches. These measures were adopted in the early part of May, 1935 and although no data has been published as yet and very few details are available at this time, it is known that, for purposes of Government supervision, the entire glass industry of Germany is divided into three main branches, namely: flat glass, hollow glass and finished glassware. The first two groups cover the production of the semi-manufactured raw materials of flat and hollow glass, from which the third group manufactures in diverse variety finished glass articles. The third group is again divided into three sub-groups: the glass-working industry, hollow glass working industry, and flat glass working industry. Especial emphasis is laid upon the first sub-division mentioned above insofar as Thuringia is concerned, in that it includes the manufacture from hollow glass of thermometers, myriads of glass instruments, thermos bottles, etc. The second sub-division embraces especially glass painting and similar industries of Saxony specializing in decorative work. The third sub-division comes under the jurisdiction of the Reichsverband der Deutschen Hohlglasindustrie (having its headquarters at Dresden) and pertains very largely to the manufacture of various kinds of medicinal glassware, flacons and bottles.

Until very recently the general interests of the glass instrument industry have been authoritatively represented by an association of manufacturers known as the Verband Deutscher Glasinstrumenten-Fabriken E. V., of Ilmenau. This association is composed of the manufacturers of chemical and pharmaceutical glassware, thermometers and airometers, clinical thermometers, surgical glassware, all glass syringes, artificial glass eyes, glass packings and ampoules, electric light bulbs, thermostatic bottles and Christmas ornaments. This association formerly occupied itself with the wage and other agreements, the collection of debts, the settlements of claims against customers, and the regulation of the supply of raw materials to thermometer manufacturers. This organization is still continuing under the same appellation, but in a somewhat modified degree in keeping with the general reorganization above alluded to, it is understood to be functioning as a sub-division (Unterfachgruppe). Although this association continues to represent the interests of the industries enumerated to a certain degree, its only official function is that of fixing sales prices for the various glass articles. It has nothing whatsoever to do with the fixing of wage scales, production quotas, working hours and similar questions, which are now under the control of Trustees of Labor (treuhander) or other agencies of the Government.

THE thermos bottle industry has been in desperate straits during the past few years, and at the beginning of 1935 both demand and prices had receded to such an unprecedentedly low level, as to necessitate intervention on the part of the German Government with a view to remedying a critical situation. By 1930 there had been such a decreased demand for thermos bottles that Thuringian factories were faced either by the contingency

of shutting down completely or working at greatly reduced time; but in spite of a definite slowing up of production, stocks on hand increased at a rate entirely disproportionate to the demand and had to be sold at a sacrifice. The result was that domestic as well as foreign buyers became exceedingly reluctant to give orders because of a feeling that at any time prices might become even lower. As a consequence of the very low prices, many department stores in Germany began a policy of offering thermos bottles at bargain rates as advertising features. This had such a derogatory effect upon the market that by December, 1930, the prices for vacuum flasks were so low that manufacturers had very scant, if any, profits and in the following years there were many desultory attempts at fixing prices by agreements between manufacturers, but until very recently these were devoid of practical results. Ultimately the situation became so acute that on February 15, 1935, the Reich's Minister of Economy issued a decree which provided for the control of the German market for thermos bottles. One section of this decree stipulates that all German manufacturers of the raw bulbs for thermos bottles and similar double-walled glass containers are compulsorily united into an association to be known as "Vertragsgemeinschaft fur Isolierflaschen zu Ilmenau." Although about thirty of the forty German factories engaged in the production of thermos bottles and related articles had agreed some years ago upon a voluntary price cartel, according to the claims of the majority of producers, the ten outsiders in the industry devastated the foreign markets for German thermos bottles, especially in Great Britain. By this latest decree compulsorily uniting all manufacturers, a strong governmental control will be exercised in the future upon production, prices, export methods, and other important business phases of the industry as a whole.

With a view to avoidance of the overproduction of the past, another section of the decree provides that until December 31, 1935, it is forbidden to establish new works for the production of raw bulbs for thermos bottles and similar articles; to enlarge the business facilities of existing firms of the said character; to increase the capacity of existing factories, and to reopen factories of this category, providing they were closed down earlier than twelve months prior to the issuance of the decree under discussion.

There is a further provision to the effect that contracts for the delivery of thermos bottles and spare parts within Germany made before the issuance of the decree, shall become null and void if the goods had not been delivered to the purchaser at the time the decree became effective, providing that the purchasing conditions were more favorable to the purchaser than the prices and general conditions fixed by the new association.

By way of illustrating the unfavorable economic situation which had developed prior to the establishment of the compulsory association, the domestic price for ordinary thermos bottles with a capacity of half a liter had been fixed by the former voluntary price cartel of German thermos bottle manufacturers at RM. 0.90. This includes a retailer's profit of 33 1/3 per cent, and a wholesaler's profit of 15 per cent. Contrary thereto, about ten German manufacturers not belonging to the cartel offered similar thermos bottles on the English market at the overwhelmingly low price of RM. 0.29.

It is stated that in 1934 the German production of thermos bottles amounted to between ten and twelve million units. Between seventy and seventy-five per cent of this amount was exported, and it is understood that from four to five million units went to Great Britain. The weight of all German thermos bottles exported in 1934 was about 3,000 metric tons, contrasted to 3,700 metric tons in 1933.

Declining exports coincident with the erection of tariff barriers in countries which formerly furnished important outlets for German electric light bulbs of the low voltage type, have also placed this branch of the glass industry in very straitened circumstances and likewise have prompted recent intervention on the part of the German Government. On March 11, 1935, the Reich's Minister of Economy issued a decree relative to the formation of an Association of German manufacturers of low voltage electric bulbs. By virtue of this decree, which became effective as of March 14, 1935, the forty-five German manufacturers of low voltage electric bulbs were compulsorily united into the above association until June 30, 1940. Of this number, forty of the factories are situated in various parts of the Thuringian Mountains, while two are in Berlin, one in Leipzig, and one in Dortmund. Details of the contemplated reorganization are not yet available, but conditions are so chaotic that drastic measures are generally expected.

In this decree the Reich's Minister of Economy reserves the right to issue in the near future the by-laws applicable to the association, which will prescribe the rights and duties of the members, and which will pertain to the administration and other problems of this somewhat harried branch of the glass industry. Pending the publication of the by-laws, according to the decree, the functions of the directors and similarly responsible parties of the association, shall be executed by a trustee appointed by the Ministry of Economy. Insofar as contracting obligations are concerned, this trustee must secure the approval of the Thuringian Minister of Economy. The trustee fixes at his discretion the production quotas of the association members. Protests against such quota fixations can be made within two weeks, and, if the trustee does not favor reconsideration, the matter will be referred to the Reich's Minister of Economy for final decision.

The first business year of the association extends from March 14, 1935, until June 30, 1936. Members of the association are obliged to pay contributions to be fixed by the Reich's Minister of Economy. If one of the members infringes any of the regulations, by-laws, or decrees issued by the Reich's Minister of Economy, the offender will be fined by a special court. No limit is set as to the amount of such a fine.

Such statistics indicate a steady decrease of exports of almost all types of glass products from 1930 to 1935, which is the most salient reason for the present depressed status of the industry. Exports of glass instruments and apparatus to practically all foreign markets fell off in the above named period, but those to the United States were subject to an especial decline, for in 1930 such exports amounted to 492.5 metric tons, valued at RM 2,699,000, and in 1934 they had shrunken to 134.7, valued at RM 614,000. (*Concluded on page* 357)

EQUIPMENT AND SUPPLIES

CATALOGS RECEIVED

Foxboro Potentiometer Controllers for Industrial Temperatures. Bulletin 202. Foxboro Co., Foxboro, Mass. An interestingly illustrated 20 page bulletin of the company's complete line of potentiometer and resistance thermometer controllers. The new Type H Drive Unit is presented, together with a number of simplified wiring diagrams to enable the reader to visualize the installation.

The Surface Illuminator for Opaque Specimens. Bausch & Lomb Optical Co., Rochester, N. Y. A new surface illuminator for illuminating opaque and translucent specimens to be examined at low magnifications.

Ideas for Xmas Merchandising. Hinde & Dauch Paper Co., Sandusky, Ohio. Illustrations and suggestions for Xmas merchandising by using wrappers and cartons of corrugated fibre board.

AT CHEMICAL EXHIBIT

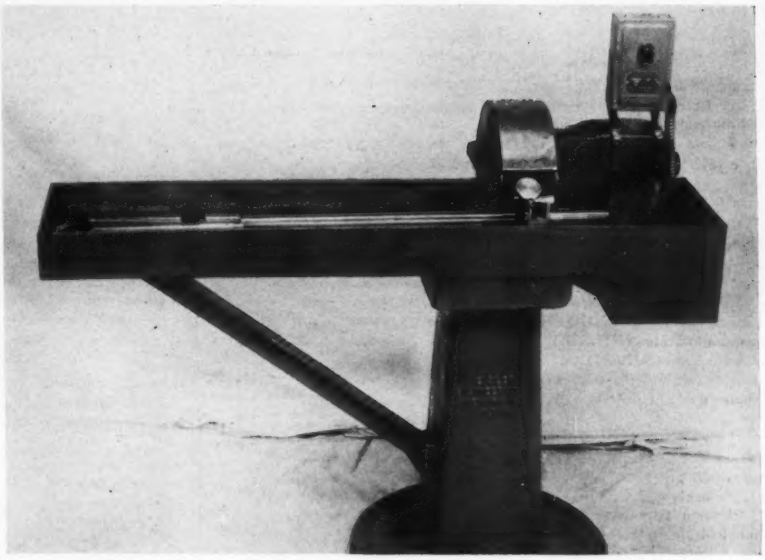
The Brown Instrument Co., Philadelphia, and the Minneapolis-Honeywell Regulator Co. will have a combined exhibit at the 15th Exposition of Chemical Industries which will be held at the Grand Central Palace, New York, Dec. 2-7. This exhibit will feature instruments particularly applicable to the chemical industries for indicating, recording and automatically controlling temperatures, pressures, flows, humidity, percentages of CO_2 and liquid levels.

NEW TEMPERATURE CONTROL METHOD

A new method of temperature control has been devised by the Wheelco Vacuum Products Co., Chicago, which features a galvanometer pointer that does no mechanical work to cause the relay to function. In other words, it performs electrically by the use of a vacuum tube rather than mechanically. This, it is claimed, enables the translation of mechanical motion on the scale to electrical function of the contactor to be made as broad as the scale or as narrow as is required.

The Wheelco Limitrol (not illustrated) is designed to operate with any auxiliary or relay means of control now in use. It can be adapted to indicate temperatures within 0°-3000°F. An indicator is set at the limit of temperature desired. When the temperature in the oven or furnace reaches this limit, a warning will be signalled by a light and bell, and the furnace or oven will be automatically shut off.

This instrument is also furnished with an automatic switch that will handle up to 39 thermocouples. The temperature at one thermocouple is indicated every 10 seconds. When the limit of temperature is reached at any thermocouple, the Limitrol will automatically deliver its signal, indicate the number of the thermocouple located in the furnace or at a point where the trouble exists. The switch will be immediately stopped and the furnace may be shut off. When this happens, it is simply necessary to press a button on the front of the instrument to set it in operation again and give the necessary attention to the point indicated.



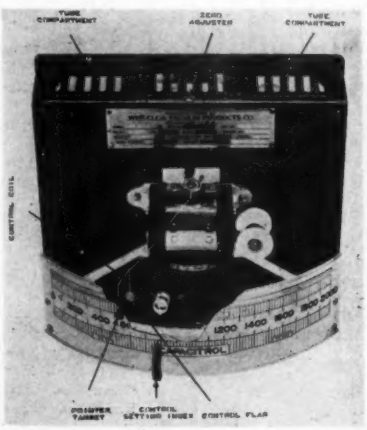
NEW HARD GLASS CUTTER

Cutting through various shaped bars, rods or tubes of hard glass, ceramics, metals and similar materials up to 2½ inches in diameter is a matter of few seconds time with the new wet-disc cutter introduced by the Eisler Engineering Co., 769 So. 13th Street, Newark, New Jersey.

The cutting tool of this machine consists of a thin abrasive wheel driven by a ¾ horsepower motor at a speed of 5,500 surface feet a minute. The wheel revolves within a cooling tank partially filled with water above the cutting level. An adjustable stop is furnished for accurately determining the correct cutting length. A quick acting clamp and long trough facilitate holding and handling the material.

In cutting a rod it is first brought against the stop which locates it for cutting length. The clamping jaw is then closed about the rod, securely holding it as it is brought against the revolving cutting wheel under water. It is immediately severed, whereupon another section is moved into position. The operation may be performed continuously and with great rapidity, resulting in very fast production.

Wet-disc cutting as performed on the above machine not only is faster but has distinct advantage over dry cutting, saw cutting and other methods. As the cutting takes place under water the dust hazard is eliminated and burning of material avoided. Wheel speed is slower with the prolongation of wheel life due to the cooling effect of the water. A wider range of materials may be cut and a smooth surface cut produced.



A control pyrometer with the "Wheelco System No Contact Control".

CURRENT PRICES OF GLASS-MAKING MATERIALS

FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS

		Carlots	Less Carlots
Acid			
Citric (dom.)	lb.	...	.29
Hydrochloric (HCl) 20° tanks	Per 100 lb.	...	1.10
Hydrofluoric (HF) 60% (lead carboy)	lb.	...	.13½
52% and 48%	lb.	.10	.10-.11½
Nitric (HNO_3) 130 lb. carboy ext. Per 100 lb.		...	5.50
Sulphuric (H_2SO_4) 66° tank cars	ton	15.50	...
Tartaric	lb.	...	Po. or Gr. .25 / Cry. .25½
Aluminum hydrate (Al $(OH)_3$)	lb.	.04-.04½	.04½-.05
Aluminum oxide (Al_2O_3)	lb.	.04	.05
Ammonium bicarbonate (f.o.b. works)	lb.	.0515	...
(f.o.b. N. Y.)	lb.	...	.0571
Ammonium bifluoride (NH_4FHF)	lb.	...	.14½
Ammonium nitrate (NH_4NO_3)	lb.	...	.08
Ammonia water (NH_4OH) 26° drums	lb.	...	.02¾
Antimonate of Sodium	lb.	...	.10½
Antimony oxide (Sb_2O_3)	lb.	...	.14¾
Antimony sulphide (Sb_2S_3)	lb.	...	.13
Arsenic trioxide (As_2O_3) (dense white) 99%	lb.	.03½	.04-.04½
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	40.00	45.00
90% through 100 mesh	ton	37.00	...
Barium hydrate ($Ba(OH)_2$)	lb.	.049	.05½
Barium nitrate ($Ba(NO_3)_2$)	lb.	...	.07¾
Barium selenite ($BaSeO_3$)	lb.	...	1.50-1.75
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f. o. b. shipping point	ton	15.00-16.00	18.00
Bone ash	lb.	.06	.06½
Borax ($Na_2B_4O_7 10H_2O$)	lb.	...	...
Granulated	In bags, lb.	.022	.0245-.027
Powdered	In bags, lb.	.0245	.027-.0295
Boric acid (H_3BO_3) granulated	In bags, lb.	.05	.0525-.055
Cadmium sulphide (CdS)—	lb.	...	.90-.95
Calcium phosphate ($Ca_3(PO_4)_2$)	lb.	.07	.07½
Chromite	lb.	...	.0215
Cerium hydrate 100 lb. drums and 600 lb. barrels	lb.	...	.65
Chrome Oxide Green, 400 lb. bbls.	lb.	.17	.215-.25
Cobalt oxide (Co_3O_4) In bbls	lb	...	1.39
In 10 lb. tins	lb.	...	1.49
Copper oxide Red (Cu_2O)	lb.	...	.25
Black (CuO)	lb.	...	.15
Black prepared	lb.	...	.22
Cryolite ($Na_3Al F_6$) Natural Greenland (Kryolith)	lb.	.08½	.09
Synthetic (Artificial)	lb.	.08½	.09
Epsom salts ($MgSO_4$) (imported) technical	Per 100 lb.	...	2.30
Feldspar— 20 mesh	ton	11.00-13.25	
40 mesh	ton	11.50-13.75	
Granular	ton	11.75-14.00	
Semi-granular	ton	11.00-13.25	
L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags			
Fluorspar (CaF_2) domestic, ground, 96-98% (max SiO_2 2½%) Bulk, carloads, f. o. b. mines	ton	30.50	...
In bags	ton	32.10	38.00-40.60
Formaldehyde, bbls.	lb.	...	.07
Graphite (C)	lb.	...	.04-.07
Iron oxide— Red (Fe_2O_3)	lb.	...	.0425
Black ($Fe3O_4$)	lb.	.04½	...
Iron chromate	lb.	...	.035-.05
Kaolin (f. o. b. mine)	ton	5.00-9.00	...
English, lump, f. o. b. New York	ton	14.50-25.00	24.50-30.00
Kryolith (see Cryolite)			
Lead chromate ($PbCrO_4$)	lb.	...	.16
Lead oxide (Pb_3O_4) (red lead) (N. Y.)	lb.	.07	...
In 5 Ton lots	lb.	...	.075
Less than 5 Tons	lb.	...	.08

		Carlots	Less Carlots
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	10.50	...
Burnt (CaO) ground, in bulk	ton	7.00	...
Burnt, ground, in paper sacks	ton	9.00	...
Burnt, ground, in 280 lb. bbls.	Per bbl.	2.25	2.25
Limestone ($CaCO_3$)	ton	1.75-2.50	...
Litharge (PbO) (New York Prices)	lb.	.06	...
In 5 Ton lots	lb.	...	.065
Less than 5 Tons	lb.	...	.07
Magnesium carbonate ($MgCO_3$)	lb.	.06	.08-.09
Magnesium sulphate (U.S.P.)	lb.	...	.0265
Manganese, Black Oxide In Paper bags	ton	50.00	52.50-55.00
In Burlap bags	ton	51.50	54.00-56.50
In Casks	ton	53.00	55.50-58.00
Neodymidm oxalate, 50 lb. drums	lb.	...	5.00
Nickel oxide (Ni_2O_3), black	lb.	...	.35-.40
Nickel monoxide (NiO), green	lb.	...	.35-.40
Plaster of Paris, bags	ton	31.00	23.00-29.00
Potassium bichromate ($K_2Cr_2O_7$)— Crystals	lb.	...	.08½
Powdered	lb.	...	.09½
Potassium carbonate Calcined (K_2CO_3) 96-98%	lb.	.06¾	.07½
Hydrated 80-85%	lb.	.06	.06¼-.06½
Potassium chromate (K_2CrO_4) 450 lb. bbls.	lb.	...	.16
Potassium hydrate (KOH) (caustic potash)	lb.	.06¼-.06½	.08-.08½
Potassium nitrate (KNO_3) (gran.)	lb.	...	.06-.06¼
Potassium permanganate ($KMnO_4$)	lb.	...	.19
Powder blue	lb.	...	.20
Rare earth hydrate 100 lb. drums	lb.	...	.35
325 lb. barrels	lb.	...	.30
Rochelle salts, bbls	lb.	...	.12½
Rouge	lb.	...	Po. or Gr. .13½ / Cry.
Rutile (TiO_2) powdered, 95%	lb.	.10-.12	.13-.15
Salt cake, glassmakers (Na_2SO_4)	ton	18.00	27.00
Selenium (Se) In 100 lb. lots	lb.	...	2.00
In lesser quantities	lb.	...	2.10
Silver nitrate ($AgNO_3$) . (100 oz. bot.) per oz.		...	.39
Soda ash (Na_2CO_3) dense, 58%— Bulk	Flat Per 100 lb.	1.10	...
In barrels	Per 100 lb.	1.50	...
In bags	Per 100 lb.	1.25	...
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.06½	.06½
Sodium chromate ($Na_2CrO_4 10H_2O$)	lb.	...	.08
Sodium fluosilicate (Na_2SiF_6)	lb.	.05	.05¼
Sodium hydrate (NaOH) (caustic soda) Flake	Per 100 lb.	3.00	...
Solid	Per 100 lb.	2.60	...
Sodium nitrate ($NaNO_3$)— Refined (gran.) in bbls.	Per 100 lb.	...	2.00-2.25
95% and 97% Bulk	Per 100 lb.	1.175	...
200 lb bags		1.24	1.29
100 lb. bags		1.275	1.325
Sodium selenite (Na_2SeO_3)	lb.	..	1.80-2.00
Sodium uranate (Na_2UO_4) Orange	lb.	...	1.50 1.55
Yellow	lb.	...	1.50-1.55
Sodium uranyl carbonate	lb.	...	.80-.90
Sulphur (S)— Flowers, in bbls	Per 100 lb.	3.35	3.70-4.10
Flowers, in bags	Per 100 lb.	3.00	3.35-3.75
Flour, heavy, in 250 lb. bbls.	Per 100 lb.	2.90	3.25-3.65
Tin chloride ($SnCl_2$) (crystals) in bbls.	lb.	...	.38
Tin oxide (SnO_2) in bbls	lb.	...	.53
Uranium oxide (UO_2) (black, 96% U_3O_8) 100 lb. lots. Black	lb.	...	3.00
Yellow orange	lb.	...	1.50
Zinc oxide (ZnO) American process, Bags	lb.	.05	.05¼
White Seal, 150 lb. bbls.	lb.	.06¾	.07
Green Seal bags	lb.	.06	.06¾
Red Seal, bags	lb.	.05½	.05¾
Zircon Granular (Milled .005-.02c higher)		.07	.67½-.08
Crude. Gran. (Milled .005-.02c higher)		.03½	.04-.05

THE THURINGIAN GLASS INDUSTRY

(Continued from page 354)

No statistics applicable solely to Thuringia are available, but as the very large proportion of such articles as glass instruments and apparatus, electric light bulbs and glass for lighting fixtures, thermometers and thermos bottles, are manufactured in Thuringia, data pertaining to national exports as a whole compiled by the official statistical office at Berlin, portray fairly closely the trend of business in the Consular District of Leipzig.

The serious economic situation faced by manufacturers of electric light bulbs alluded to in this report, is reflected in export figures which indicate that in 1930 shipments to all parts of the works amounted to 16,137 metric tons, valued at RM 2,979,000, whereas in 1934, such exports had dwindled to 4,175 metric tons, valued at RM 779,000. Exports of electric light bulbs to the United States have never been of great importance, having amounted in 1933 to 116 metric tons, valued at RM 25,000 and in 1934 to 154 metric tons, value 22,000.

The general downward slide of exports of thermometers from 1930 to 1935 has not been so apparent in quantity, but depressed prices have been responsible for a drop of about 50 per cent in valuation. Exports of thermometers to the United States, however, have declined very appreciably, for in 1930, 514 metric tons, valued at RM 488,000 were shipped, while the exports of thermometers in 1934 came only to 172 metric tons, valued at RM 110,000. In former years the United States furnished the best market for Thuringian thermometers, but in 1934 there were considerably higher exports to France, Sweden, Switzerland, Netherlands, and Italy, to each, respectively, in the order named.

As intimated in a preceding section of this report. exports of thermos bottles to Great Britain have been very heavy during the past five years, and this fact alone has tended to keep up the level of shipments insofar as quantities are concerned, but the unhealthy competition which has evoked governmental intervention, not to mention a considerable amount of dumped goods, have caused a sharp decline in valuation. National statistics indicate that in 1930, 36,412 metric tons of thermos bottles, valued at RM 9,129,000 were exported to all parts of the world, whereas similar shipments in 1934 amounted to 30,024 metric tons, valued at only RM 4,-464,000. The United States formerly constituted a lucrative market for Thuringian thermos bottles; but during the last year this market has almost entirely disappeared.

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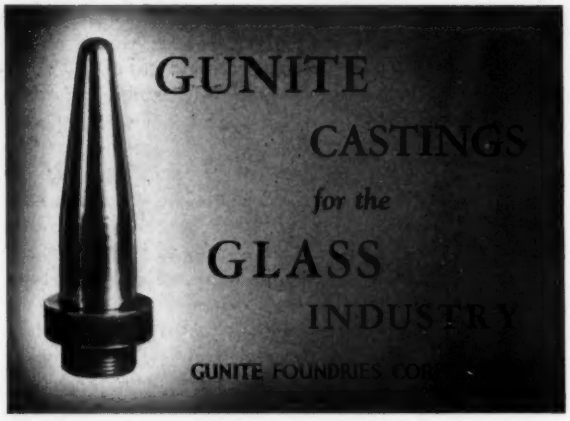

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